Nationwide Food Consumption Survey
Report No. 87-M-2

Evaluation of Nonresponse in the Nationwide Food Consumption Survey, 1987-88

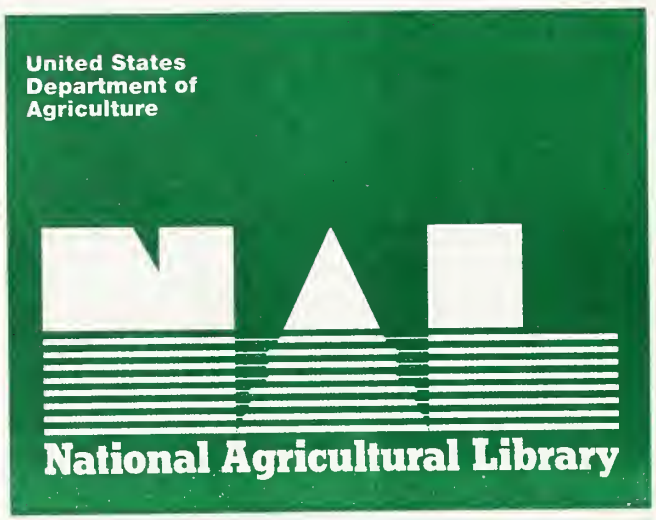
U.S. Department of Agriculture ■ Human Nutrition Information Service

Abstract

Response rates for the 1987-88 Nationwide Food Consumption Survey (NFCS 1987-88) were very low--38 percent at the household level and 31 percent at the individual level. This publication provides information on the procedures used in NFCS 1987-88, the response rates, and the characteristics of the unweighted sample compared with population estimates from the U.S. Bureau of the Census. The regression weighting approach used to adjust for nonresponse is described. Analyses done to evaluate the effect of nonresponse on estimates of food and nutrient intakes in NFCS 1987-88 are presented. Results of a study of attrition suggested that the regression weighting may correct nonresponse bias. The study showed that differences between respondents and nonrespondents in eating behavior were predictable because they were caused by known socioeconomic variables, which can be adjusted for by weighting, and were not caused by some other unknown and nonrandom, and thus unpredictable, response propensity. Also, a comparison of NFCS 1987-88 with the NFCS 1977-78 and the 1985 and 1986 Continuing Survey of Food Intakes by Individuals revealed that differences in results appeared to be caused by the differences in methodology, design, and target samples rather than by nonresponse. Despite the low response rate, the NFCS 1987-88 provides better estimates of current dietary intake than does the NFCS 1977-78. Users must balance their need for the data and their tolerance for error against the limitations of the data.

Keywords: Dietary survey, food intakes, nonresponse.

Suggested Citation: Guenther, P.M., and Tippett, K.S. (eds.). 1993. Evaluation of Nonresponse in the Nationwide Food Consumption Survey, 1987-88. Washington: U.S. Dept. of Agriculture, Human Nutrition Information Service. Nationwide Food Consumption Survey 1987-88, NFCS Rep. No. 87-M-2, 76 pp.



September 1993

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Editors

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Acknowledgments

In addition to the authors who conducted the analyses and wrote specific sections of this report, the following Human Nutrition Information Service staff members contributed either to the data analyses or to the editing and production of the report: Joseph D. Goldman, Mary Y. Hama, James T. Heimbach, Renee A. Powell, Johna L. Pierce, Joanne Rosenthal Levine, Gerald L. Smith, Carol A. Nathan, and Katherine E. Sykes.

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Introduction

The 1987-88 Nationwide Food Consumption Survey (NFCS 1987-88) is the most recent of seven decennial surveys that have been conducted by the U.S. Department of Agriculture (USDA). The surveys are used to describe food consumption behavior and to assess the nutritional content of diets of Americans. The information generated by these surveys is used to develop policies on nutrition education, food production and marketing, food assistance programs, and food safety.

NFCS 1987-88 included the collection of two types of information on food consumption: (1) food used by households during a 7-day period and the cost of that food and (2) food eaten by individuals in the same households during a 3-day period. The survey was conducted by National Analysts, a division of Booz, Allen, and Hamilton, under contract with USDA. The household data and the first day of individual data were collected in personal, in-home interviews. The second and third days of individual data were collected by a self-administered record.

Data collection for the survey began on April 1, 1987, and was expected to be completed by March 31, 1988. Because of low response rates in the first quarter of the survey, adjustments were made to increase the sample size in subsequent quarters and data collection was extended into August 1988. Efforts to increase the response rates were not very successful. The final response rates were very low--38 percent of sample households that were occupied agreed to participate. Within these participating households, 81 percent of the eligible individuals provided at least 1 day of intake data, yielding an estimated individual response rate of 31 percent.

The Human Nutrition Information Service (HNIS) contracted with the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) to conduct an independent review of the impact of nonresponse on estimates of food and nutrient intakes in the NFCS. LSRO convened a panel of statisticians (Expert Panel) who reviewed the design and execution of the NFCS, evaluated studies on nonresponse conducted by HNIS, and made recommendations about the useability of the data. The main text of the LSRO report is an appendix to this publication. Many of the tables and figures that appear in the LSRO report appendixes are used in this publication.[1]

This publication on nonresponse in the NFCS 1987-88 serves two purposes: to provide information on the data collection procedures used in NFCS 1987-88, the response rates, and a discussion of the weighting approach used to adjust for nonresponse (chapters 1, 2, and 3); and to describe the analyses conducted by HNIS to evaluate the effect of nonresponse in the NFCS (chapters 4 and 5).

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[1]The complete LSRO report can be obtained from FASEB Special Publications Office, 9650 Rockville Pike, Bethesda, MD 20814. The cost is $24 (plus 5 percent sales tax for Maryland residents).

Chapter 1: Background

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Sample Design

The NFCS 1987-88 sample was designed to be a self-weighting, multistage, stratified, area probability sample of households in the 48 conterminous States. The sampling frame was organized using estimates of the U.S. population in 1980. Adjustments were made to the sampling frame at the time of the survey to reflect the 1987 population. The target sample was 6,000 households; these households were expected to yield about 15,000 individuals. NFCS 1987-88 included two samples--a basic sample of households at all levels of income and a low-income sample of households with incomes at or below 130 percent of the poverty thresholds provided by the U.S. Bureau of the Census. This report on nonresponse covers the basic sample only.

The stratification plan took into account geographic location, degree of urbanization, and socioeconomic considerations. Each successive sampling stage selected smaller, more specific locations. The 48 States were grouped into the nine census geographic divisions. Then all land areas within the divisions were divided into three urbanization classifications: metropolitan central city, metropolitan noncentral city (suburban), and nonmetropolitan. Thus, all cities and counties in the conterminous United States were classified into 27 superstrata.

The 27 superstrata were further divided into 60 strata, which correspond to the geographic distribution, urbanization, and density of the population within the conterminous United States. The average size of these strata was approximately 4 million persons. Smaller, relatively homogeneous units, called primary sampling units (PSU), were formed by counties or combining counties in nonmetropolitan strata, by cities or parts of cities in central city strata, and by counties or the balance of counties having central cities in suburban strata. Two PSU's were selected for each of the 60 strata. The two PSU's were selected from each stratum with replacement; that is, the selection of one PSU did not preclude its selection as the second PSU. Because one PSU drawn into the sample was completely lost to nonresponse, the final sample included 119 PSU's.

Each selected PSU was divided geographically along census boundaries into smaller clusters, known as area segments, containing a minimum of 100 housing units. These segments usually consisted of one or more city blocks in urban areas and part of a census enumeration district elsewhere. A total of 1,000 area segments were drawn into the sample across all PSU's to maximize spread of interviews in the PSU, to create efficient interviewer workloads, and to target, on average, six interviewed households per area segment.

The 1,000 area segments were prelisted prior to the survey to identify the existing housing units within the area boundaries. The prelisted number of housing units in the area as of 1987, together with estimates of occupancy and completion rates, served as the basis for determining the number of housing units to be selected for the sample from that area.

NFCS 1987-88 was to include a followup survey of nonresponding households to determine some of their characteristics; however, this survey was not conducted.

More detail on the sample design of NFCS 1987-88 is available in appendix A of the LSRO report (1)[2] and in NFCS Report No. 87-I-1, which gives results of the individual intake component (2).

Data Collection

To contact individuals in housing units selected as part of the sample, interviewers made a minimum of three personal visits plus up to eight telephone calls to each household having a telephone. To contact households without telephones, interviewers increased the number of personal visits, when necessary, to six (five in rural areas). Interviewers were expected to make up to six call-back attempts in urban areas and five in rural areas. These attempts were to be on different days of the week with at least one attempt on a weekend. The day was divided into

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[2]Numbers in parentheses refer to references in the section "Literature Cited."

four parts (morning, early afternoon, late afternoon, and evening), and attempts to contact a sample household were to be made during each of these periods, if needed.

The interviewer asked to speak with the person most responsible for planning or preparing meals and provided this person with a letter of introduction and described the survey. The respondent was asked to save all food-purchase receipts for the next 7 days along with food labels, recipes, and other reminders of foods served over the period. The interviewer returned 7 days later to conduct the survey with the aid of a laptop computer.

A list-aided recall method was used to collect the types, amounts, and costs (if purchased) of all the foods used by the household during the previous 7 days. Then the interviewer completed a 1-day recall of food intake for each household member present.

The main meal planner/preparer was asked to report for any children under the age of 12 and for absent members of the household. If the main meal planner/preparer could not supply the information, the recall form was left at the household to be reviewed or completed by the absent person.

The interviewer then described the 2-day dietary record and helped each household member begin a record of the current day's intake. The interviewer returned 2 to 4 days later to collect and review the 2-day records and distribute the monetary incentives of $2 per completed 3-day recall-plus-record set.

The survey design called for all sample housing units selected in each quarterly sample to be contacted, and interviews completed, during the designated 3-month period. As the fieldwork progressed, it became apparent that this goal could not be achieved. Successful resolutions of contacts with sample households were not being obtained during the designated 3-month period. It was therefore decided to continue attempting contacts and interviews with sample housing units beyond the initial period. Further, because of the lower than anticipated response rate in the first quarter, the sampling rate was increased in the second, third, and fourth quarters. Table 1 provides information on participation levels for each quarterly sample.

Response Rates

The response rates were very low. Only 38 percent of targeted occupied housing units participated (table 2). Some participating households did not provide complete food use information; therefore, the final response rate for the household component of the NFCS was 37 percent. Response rates for the individual intake component of the survey were calculated separately. Of the individuals living in participating households, 81 percent completed the day 1 intake (an estimated overall response rate of 31 percent); and 83 percent of those individuals who completed the first day of intake completed all 3 days, yielding an estimated overall 3-day response rate of 25 percent.

Reasons for nonresponse were numerous. Interviewers failed to contact about 17 percent of sample households, 14 percent of contacted households refused to be screened, and 45 percent of those screened refused to participate in the interview. A high rate of turnover of interviewers, interviewers' failure to follow prescribed schedules, insufficient training and monitoring of the interviewers, and less-than-effective screening and interview techniques all contributed to the poor response rates (1).

The length of the interview, which averaged 2.7 hours, also contributed to the low response. Many people refused to participate after being informed of the requirements of the survey. Other suspected reasons for the low response rate include an increase in the proportion of women who are in the work force, and thus are less likely to be home or to be willing to devote time to a long interview; the increased number of surveys by many types of organizations; greater concern about letting strangers into the home; and a lack of worthwhile incentives to participate.

Nonresponse Adjustments

As the level of nonresponse became apparent, HNIS staff decided that traditional nonresponse adjustments based only on geography and the small number of variables available from census data (age, sex, race, and income) could not adequately correct for potential nonresponse bias. The analysis of the unweighted NFCS sample presented in chapter 2 confirmed that other variables such as household composition and employment status should be addressed. A weighting approach, developed at Iowa State University, that controls for additional variables in a regression analysis

was employed to reduce potential nonresponse bias. The demographic variables controlled for are listed in chapter 2. In addition to these variables, day of the week and month of the interview were controlled because these temporal characteristics were seriously unbalanced. If these variables were not controlled, biased estimates, unrelated to nonresponse, could result. Construction and efficiency of weighting factors are discussed in chapter 3.

Table 1. Participation levels for the 1987-88 Nationwide Food Consumption Survey, basic sample, by quarter

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Housing units in sampling frame	2,187	3,055	4,677	3,814	13,733
Occupied housing units	1,947	2,702	4,142	3,390	12,181
Contacted households	1,649	2,132	3,398	2,756	9,935
Screened households	1,393	1,855	2,860	2,342	8,450
Participating households	847	1,032	1,540	1,170	4,589
Households completing household component	822	1,011	1,503	1,159	4,495
Households participating in individual component	756	920	1,398	1,040	4,114
Individuals in participating households	2,291	2,729	4,264	3,238	12,522
Individuals completing day 1	1,860	2,229	3,507	2,576	10,172
Individuals completing 3 days	1,597	1,901	2,925	2,045	8,468
Reason occupied housing units not contacted:					
No one home; no answer	292	538	702	583	2,115
No access	6	32	42	51	131
Reason contacted households not screened:					
Refused screening	248	251	492	379	1,370
Language barrier	8	26	46	35	115
Reason screened households did not participate:					
Refused interview	537	789	1,264	1,112	3,702
Other	9	34	56	60	159

Table 2. Response rates in the 1987-88 Nationwide Food Consumption Survey, basic sample

Housing units selected	13,733	
Occupied housing units	12,181	(89% of housing units selected)
Contacted households	9,935	(82% of occupied housing units)
Screened households	8,450	(69% of occupied housing units; 85% of contacted households)
Participating households	4,589	(38% of occupied housing units; 54% of screened households)
Households with completed food use questionnaires	4,495	(98% of participating households; 37% of occupied housing units; 53% of screened households)
Individuals in participating households	12,522	
Individuals completing day 1 recall	10,172	(81% of individuals in participating households; estimated 31% of individuals in all occupied housing units)
Individuals completing 3 days recall/records	8,468	(83% of individuals completing day 1 recall; 68% of individuals in participating households; estimated 25% of individuals in all occupied housing units)

Chapter 2. Demographic Characteristics of the Sample

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Although a survey sample may be carefully designed to include all segments of a population of interest, some proportion of the selected sample typically will fail to respond, as in NFCS 1987-88. If nonresponse is random throughout the selected sample, the respondents can still be expected to represent the population of interest. However, if respondents and nonrespondents have systematically different food consumption patterns, then the respondents may not represent the target population, possibly biasing the survey results. The magnitude of this bias is determined by the overall response rate and the level of difference between the mean values of survey variables for respondents and the mean values of survey variables for nonrespondents. Unfortunately, because nonrespondents did not respond, there is no information on what they ate and, therefore, an assessment of nonresponse bias is difficult.

It is possible to compare characteristics of respondents with population estimates from other sources. This section contains a comparison of the demographic characteristics of those responding to NFCS 1987-88 with estimates from the 1987 Current Population Survey (CPS), March Supplement, conducted by the U.S. Bureau of the Census for the Bureau of Labor Statistics (3). The CPS contains data which are used to estimate demographic characteristics of the U.S. population. Since research and experience have shown that food consumption patterns relate in part to various sociodemographic variables, a comparison of distributions of sociodemographic variables in NFCS and CPS permits some indirect inferences regarding nonresponse bias that would result if the unweighted NFCS data were used for analysis.

Demographic characteristics from households and individuals participating in NFCS 1987-88, prior to weighting, were compared with characteristics of the general population as estimated by the 1987 CPS. Since the original NFCS sample was designed to be self-weighting, the unweighted NFCS results and the CPS estimates could have been expected to agree within sampling error if there had been complete response.

The characteristics chosen for the comparison have been shown by research and experience to be related to food consumption (4, 5, 6, 7). Fourteen characteristics were compared for the household component and 13 for the individual intake component; these characteristics are listed in tables 3 and 4.

The individual intake analysis was done separately for three sex-age groups: men 20 years of age and over, women 20 years of age and over, and persons under 20 years of age. Tables 3 and 4 provide the NFCS sample percents, the population percents as estimated from the CPS, and the absolute t values for both the household and the individual analyses. All differences between the sample and the population proportions are less than 8 percentage points. However, there are 16 individual differences and 4 household differences with absolute t values greater than 3.0. (Each t value is a NFCS sample proportion minus the corresponding CPS population proportion divided by the sample proportion's estimated standard error using RTIFREQS (8). Because the variance of the CPS estimate is ignored, this t value is slightly inflated.) Focusing on absolute t values greater than 3.0 rather than the more conventional bound of 2.0 (or 1.96) provides a crude adjustment for the number of comparisons being made.

The statistical analysis suggests that more than random chance led to the sample having the following characteristics relative to the CPS population estimates:

Households:

(1) A smaller proportion from high-income households
(2) A larger proportion of households with both a male and a female head and a smaller proportion of households with a male head only
(3) A larger proportion of households with exactly two adults

Individuals:

(1) A larger proportion of individuals from low-income households and a smaller proportion from high-income households
(2) A larger proportion of individuals from households with exactly two adults
(3) A smaller proportion of women from households with working female heads

Individuals (continued):

(4) A smaller proportion of men from households with working male heads
(5) A smaller proportion of men and women from households with a female head under 41 years of age and no children
(6) Smaller proportions of individuals 20 to 24 years of age and 15 to 19 years of age

These results suggest that an analysis of unweighted NFCS data could be seriously biased because of differences between the sample and its target population in characteristics believed to be related to food consumption. However, use of the weighting factors discussed in the next chapter should reduce, and perhaps even eliminate, these potential sources of bias.

Table 3. NFCS 1987-88 household component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, 1987

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
Region:				
Northeast	905	20.1	21.2	0.3
Midwest	1,172	26.1	24.7	.3
South	1,567	34.9	34.4	.1
West	851	18.9	19.6	.2
Urbanization:				
Central City	1,064	23.7	31.2	1.7
Suburban	2,122	47.2	46.0	.2
Nonmetro	1,309	29.1	22.9	1.3
Household income as a percentage of poverty level:				
< 131%	1,041	23.2	20.0	2.2
131-300%	1,564	34.8	32.2	2.4
301-500%	1,108	24.6	25.9	1.3
over 500%	782	17.4	21.8	3.4
Household presently receiving food stamps:				
Yes	314	7.0	7.4	.6
No	4,181	93.0	92.6	
Owns domicile:				
Yes	2,998	66.7	64.1	1.5
No	1,497	33.3	35.9	
Race of household head:				
Black	519	11.5	11.1	.3
Nonblack	3,976	88.5	88.9	
Age of household head:				
< 25	338	7.5	7.9	.5
25-39	1,588	35.3	36.1	.8
40-59	1,369	30.5	30.5	.0
60-69	660	14.7	13.0	2.6
70 +	540	12.0	12.6	.8

Continued

Table 3. NFCS 1987-88 household component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, 1987—continued

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
Household head status:				
Both male and and female	3,057	68.0	60.8	6.2
Female only	1,044	23.2	26.0	2.7
Male only	394	8.8	13.2	8.6
Female head worked last week:				
Yes	1,792	39.9	41.5	1.5
No	2,703	60.1	58.5	
Exactly one adult in household:				
Yes	1,211	26.9	29.7	2.6
No	3,284	73.1	70.3	
Exactly two adults in household:				
Yes	2,616	58.2	54.2	4.1
No	1,879	41.8	45.8	
Presence of child under age 7:				
Yes	1,009	22.4	20.1	2.9
No	3,486	77.6	79.9	
Presence of child age 7 to 17:				
Yes	1,309	29.1	26.5	2.8
No	3,186	70.9	73.5	
Household size, mean:		2.7	2.6	1.6
Household size squared, mean:		9.5	9.1	1.2

Table 4. NFCS 1987-88 individual intake component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, by sex-age category, 1987

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
(a) Men 20 years old and over				
Region:				
Northeast	664	21.0	21.2	0.0
Midwest	813	25.7	24.4	.3
South	1,105	35.0	34.1	.2
West	576	18.2	20.3	.5
Household income as percentage of poverty level:				
< 131%	547	17.3	12.6	3.9
131-300%	1,101	34.9	31.3	2.6
301-500%	863	27.3	29.2	1.6
over 500%	647	20.5	26.8	4.0
Presence of child under age 7:				
Yes	696	22.0	20.7	1.4
No	2,462	78.0	79.3	
Presence of child age 7 to 17:				
Yes	912	28.9	27.7	1.1
No	2,246	71.1	72.3	
Exactly one adult in household:				
Yes	317	10.0	11.7	2.6
No	2,841	90.0	88.3	
Exactly two adults in household:				
Yes	2,101	66.5	59.8	6.7
No	1,057	33.5	40.2	
Household member receives food stamps:				
Yes	121	3.8	4.5	1.4
No	3,037	96.2	95.5	
Owns dwelling:				
Yes	2,294	72.6	70.2	1.5
No	864	27.4	29.8	
Male head worked last week:				
Yes	2,123	67.2	72.5	4.4
No	1,035	32.8	27.5	
Female head worked last week:				
Yes	1,217	38.5	41.7	2.5
No	1,941	61.5	58.3	

Continued

Table 4. NFCS 1987-88 individual intake component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, by sex-age category, 1987—continued

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
(a) Men 20 years old and over				
Female head under age 41 and no child under age 18:				
Yes	269	8.5	12.2	6.2
No	2,889	91.5	87.8	
Race:				
Black	257	8.1	10.1	1.2
Nonblack	2,901	91.9	89.9	
Age:				
20-24	280	8.9	11.7	4.8
25-39	1,148	36.4	37.5	1.2
40-59	970	30.7	29.8	.9
60-69	433	13.7	11.9	2.6
70 +	327	10.4	9.0	1.7
(b) Women 20 years old and over				
Region:				
Northeast	826	20.8	21.7	0.2
Midwest	988	24.9	24.5	.1
South	1,424	35.9	34.1	.3
West	729	18.4	19.7	.3
Household income as percentage of poverty level:				
< 131%	934	23.5	19.1	2.8
131-300%	1,429	36.0	32.4	3.3
301-500%	959	24.2	26.5	2.3
over 500%	645	16.3	22.0	4.4
Presence of child under age 7:				
Yes	922	23.2	22.1	1.1
No	3,045	76.8	77.9	
Presence of child age 7 to 17:				
Yes	1,186	29.9	29.3	.6
No	2,781	70.1	70.7	
Exactly one adult in household:				
Yes	808	20.4	19.9	.5
No	3,159	79.6	80.1	
Exactly two adults in household:				
Yes	2,360	59.5	55.5	3.7
No	1,607	40.5	44.5	

Continued

Table 4. NFCS 1987-88 individual intake component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, by sex-age category, 1987—continued

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
(b) Women 20 years old and over				
Household member receives food stamps:				
Yes	286	7.2	7.7	.6
No	3,681	92.8	92.3	
Owns dwelling:				
Yes	2,734	68.9	68.1	.4
No	1,233	31.1	31.9	
Male head worked last week:				
Yes	1,993	50.2	50.9	.5
No	1,974	49.8	49.1	
Female head worked last week:				
Yes	1,720	43.4	50.6	5.6
No	2,247	56.6	49.4	
Female head under age 41 and no child under age 18:				
Yes	444	11.2	18.4	9.0
No	3,523	88.8	81.6	
Race:				
Black	473	11.9	11.4	.3
Nonblack	3,494	88.1	88.6	
Age:				
20-24	344	8.7	11.2	4.2
25-39	1,384	34.9	35.0	.1
40-59	1,153	29.1	28.7	.3
60-69	590	14.9	12.5	3.4
70 +	496	12.5	12.6	.1
(c) Persons under 20 years old				
Region:				
Northeast	585	19.2	19.3	0.0
Midwest	853	28.0	25.3	.5
South	992	32.6	34.6	.4
West	617	20.2	20.9	.1
Household income as a percent of poverty level:				
< 131%	948	31.1	26.3	2.2
131-300%	1,236	40.6	37.7	1.6
301-500%	606	19.9	24.3	3.2
over 500%	257	8.4	11.8	3.0

Continued

Table 4. NFCS 1987-88 individual intake component: Comparisons of the unweighted sample (NFCS) and population (CPS) characteristics, by sex-age category, 1987—continued

Characteristic	Number in sample	Percent of sample	Percent of population	| t value |
(c) Persons under 20 years old				
Presence of child under age 7:				
Yes	1,741	57.1	54.2	2.0
No	1,306	42.9	45.8	
Presence of child age 7 to 17:				
Yes	2,205	72.4	72.5	.1
No	842	27.6	27.5	
Exactly one adult in household:				
Yes	427	14.0	13.9	.1
No	2,620	86.0	86.1	
Exactly two adults in household:				
Yes	2,113	69.3	62.7	4.8
No	934	30.7	37.3	
Household member receives food stamps:				
Yes	426	14.0	14.8	.5
No	2,621	86.0	85.2	
Owns dwelling:				
Yes	1,995	65.5	64.3	.5
No	1,052	34.5	35.7	
Male head worked last week:				
Yes	2,155	70.7	68.9	1.1
No	892	29.3	31.1	
Female head worked last week:				
Yes	1,421	46.6	49.7	1.8
No	1,626	3.4	50.3	
Female head under age 41 and no child under age 18:				
Yes	26	0.9	1.0	.9
No	3,021	99.1	99.0	
Race:				
Black	425	13.9	15.6	.7
Nonblack	2,622	86.1	84.4	
Age:				
0-4	840	27.6	26.1	1.4
5-9	820	26.9	25.0	2.4
10-14	703	23.1	23.4	.4
15-19	684	22.4	25.5	3.2

Chapter 3: Construction of Weighting Factors

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The objective of weighting is to make the sample more nearly representative of the population. Because the Current Population Survey (CPS) provides estimates of demographic characteristics for the population, it can be used to improve estimates derived from the NFCS 1987-88 data. One way to do this is to compute a weight for each observation. For example, assume it is known that 15 percent of the population is in category A, but only 12 percent of the sample falls in the category. Then it is reasonable to assign larger weights to individuals in category A and smaller weights to those not in A, so that the estimated fraction for category A constructed with the weights is the population fraction of 15 percent. In a similar manner, if the population mean of a variable is known and if the sample mean is smaller than the population mean, the procedure we adopt assigns larger weights to large observations and smaller weights to small observations so that the weighted sample average becomes the population mean.

Two common methods of computing weights using known totals of auxiliary variables are post stratification and regression. In post stratification, the population is divided into a number, say $k + 1$, of mutually exclusive and exhaustive cells where the population number in each cell is known or estimated from another source. The sample is partitioned into the same cells. If the original sample is self-weighting, the weight for an observation is the population number divided by the sample number for the cell in which the observation appears.

In regression estimation, a row vector of variables denoted by $X_{i.}$ is available for the i-th individual, and the population totals $X_{..} = (X_{.1},X_{.2},...,X_{.k})$ for the vector are known or estimated from another source. A set of weights $w = (w_1,w_2,...,w_n)'$ is chosen to minimize a function of the weights, say $g(w)$, subject to the restrictions

$$\sum_{i=1}^{n} w_i X_{ij} = X_{.j}, \quad j = 1,2,...,k,$$

where X_{ij} is the value of characteristic j for individual i, and $X_{.j}$ is the population total for characteristic j. Post stratification is a special case of regression estimation in which the vector $X_{i.}$ is composed of k indicator variables for k of the $k + 1$ post strata. Regression estimation is discussed by Cochran (9), Bethlehem and Keller (10), and Deville and Sarndal (11). The regression method of weight construction was chosen for NFCS 1987-88 because of its generality and flexibility.

In ordinary regression estimation for a simple random sample, it is common to minimize

$$g(w) = \sum_{i=1}^{n} w_i^2$$

to obtain the ordinary regression estimator. If the original sample is self-weighting, the ordinary regression estimator of the total of a characteristic Y can be written as

$$\hat{Y} = N [\bar{y} + (\bar{X}_{..} - \bar{x}_{..}) \hat{\beta}]$$

or as

$$\hat{Y} = \sum_{i=1}^{n} w_i Y_i,$$

where

$$\hat{\beta} = \left[\sum_{i=1}^{n} (X_{i.} - \bar{x}_{..})' (X_{i.} - \bar{x}_{..}) \right]^{-1} \sum_{i=1}^{n} (X_{i.} - \bar{x}_{..})' (Y_{i.} - \bar{y}_{.}),$$

$$(\bar{x}_{..}, \bar{y}_{.}) = n^{-1} \sum_{i=1}^{n} (X_{i.}, Y_{i}),$$

$$w_i = n^{-1} + (\bar{X}_{..} - \bar{x}_{..}) \left[\sum_{g=1}^{n} (X_{g.} - \bar{x}_{..})' (X_{g.} - \bar{x}_{..}) \right]^{-1} (X_{i.} - \bar{x}_{..})',$$

$X_{..} = N\bar{X}_{..}$,

and N is the number of elements in the population.

The weights for the regression estimator of the total have the following desirable properties:

1. The weights, once computed, can be applied to all y-characteristics.
2. The sample weights applied to the x-characteristics yield the true total of x.
3. The sum of the sample weights for estimating the total is N, where N is the number of elements in the population.

Weights constructed by the ordinary regression formulas may be negative for observations far from the mean. To create weights that are always positive, a modified regression weight generation method developed by Huang and Fuller (12) was applied to the NFCS data.

Regression weights were constructed for three data sets: the household data, the day 1 intake data, and the 3-day intake data. The household data set consists of 4,495 households; the day 1 intake data set, 10,172 individuals; and the 3-day intake data set, 8,468 individuals.

Household Data

Weight construction—To generate weights, each of the categorical variables in table 4 (see chapter 2) was converted to a set of indicator variables. For example, three variables were created for the characteristic household income as a percentage of the poverty level, where

Z_{t1}	= 1	if income < 131% for t-th household,
	= 0	otherwise;
Z_{t2}	= 1	if income is 131-300% for t-th household,
	= 0	otherwise;
Z_{t3}	= 1	if income is 301-500% for t-th household,
	= 0	otherwise.

The fourth category of household income as a percentage of the poverty level, > 500 percent, was represented by setting Z_{t1}, Z_{t2}, and Z_{t3} to zero. In addition to the variables of table 4, three indicator variables were created for the four seasons (table 5).

Table 5.–Seasonal distribution of household sample

Season	Sample frequency	Sample percentage	Target percentage
Spring (April-June)	1,828	40.7	25.0
Summer (July-September)	678	15.1	25.0
Fall (October-December)	717	16.0	25.0
Winter (January-March)	1,272	28.3	25.0

Employing this procedure, 25 indicator variables were created for the household data set. In addition, household size and the square of household size were used as continuous variables.

The 27 variables were used to generate regression weights using the program developed by Huang and Fuller (12). Constant starting weights were used. One iteration was required to produce a set of real weights such that

$$\sum_{t=1}^{n} w_t X_{tj} = X_j$$

for each of the control variables, where w_t is the weight for the t-th observation, X_{tj} is the value of the j-th control variable for the t-th observation, n is the number of observations in the group, and X_j is the population total for the j-th control variable. The weights were then rounded to integer weights, where each weight is a weight in thousands. The sum of the integer weights is the population total in thousands.

The sum of the final weights is 88,942, which is the number of households in the population in thousands. The average weight is 19.79, the smallest weight is 6, and the largest weight is 47. Thus, the largest weight is 2.38 times the average weight. The average of the squares of the weights is 515.7. The square of the average weight is 391.5. Thus, if a variable has zero multiple correlation with the 27 variables, the variance of an estimate computed with the weights will be about (515.7/391.5 =) 1.32 times the variance of the simple unweighted estimator.

Efficiency Comparisons—To compare estimates constructed with weights to unweighted estimates, we use these household-level variables:

Y_1 = adjusted total number of meals away from home (meals away),
Y_2 = total money value of food used at home (home food), and
Y_3 = household size in 21-meal-equivalent persons (meal-persons).

The household size in 21-meal-equivalent persons is the total adjusted meals eaten from household food supplies in the past 7 days. "Meal persons" is the sum of two terms. The first term is the sum of the proportions of meals eaten at home in the interview week by each household member. The second term is the number of meals served to guests, boarders, and employees during the interview week, divided by 21. In other words:

$$\text{Meal persons for t-th household} = \sum_{i} \frac{h_{it}}{h_{it} + a_{it}} + \frac{b_t}{21},$$

where

h_{it} = meals eaten at home by the i-th individual in the t-th household during the interview week,
a_{it} = meals eaten away from home by the i-th individual in the t-th household during the interview week,

and

b_t = number of meals eaten by nonhousehold members in the t-th household during the interview week.

The adjusted total number of meals eaten away from home is the sum of the proportions of meals eaten away from home in the interview week by household members, multiplied by 21. In the notation above,

$$\text{meals away for t-th household} = \left(\sum_{i} \frac{a_{it}}{h_{it} + a_{it}} \right) \times 21.$$

The total money value of food used at home is the expenditures for purchased food plus the money value of home-produced food and food received free of cost that was used during the survey week. Expenditures for purchased food were based on prices reported as paid regardless of the time of purchase; sales tax was excluded. Purchased food with unreported prices, food produced at home, food received as a gift, and food received instead of pay were valued at the average price per pound paid for comparable food by survey households in the same region and season.

The means of the variables computed using unweighted data are given in table 6 in the column headed "Unweighted mean." The standard errors of the estimates are given in parentheses below the estimates. The estimates and standard errors for the unweighted estimates were computed in PC CARP (13). The stratified cluster sample design of the NFCS 1987-88 was accounted for in the computations.

Table 6.--Properties of alternative estimators for selected household variables

Variable	Unweighted mean	Weighted mean	Difference	Relative efficiency of regression
Meals away	8.27 (0.22)	8.57 (0.22)	-0.30 (0.12)	2.56
Home food	59.37 (1.12)	57.49 (0.91)	1.88 (0.39)	5.60
Meal-persons	2.33 (0.03)	2.22 (0.01)	0.11 (0.01)	129.00

The variance of an estimate from a clustered sample of households is generally greater than the variance from a simple random sample containing the same number of households. The ratio of these two variances is called the design effect. Estimated design effects of the unweighted means for selected household variables are presented in table 7.

Table 7.--Design effects of unweighted means for selected household variables

Variable	Design effect
Meals away	2.5
Home food	4.1
Meal-persons	2.5

The column of table 6 headed "Weighted mean" contains the estimates computed with the regression weights. The standard errors, given in parentheses, were computed in PC CARP using the variance formula for regression estimation. The variance calculation requires computing a regression for every variable. The standard errors for unweighted and weighted estimates for meals away and for home food are similar; however, the standard errors for the regression estimate of the population mean of meal-persons are about one-third of the standard error of the unweighted estimate. The standard error of the regression estimator is smaller because meal-persons is highly correlated with the household size variables used as controls in the regression procedure.

The estimated multiple correlation, R^2, between the variables in the table and the 27 control variables is 0.29, 0.44, and 0.82 for meals away, home food, and meal-persons. If the sample means of the control variables were nearly equal to the population means, the standard error of the regression estimate of meals away would be about $\sqrt{(1 - R^2)} = 0.84$ times the standard error of the unweighted estimate. In fact, the estimated standard error of the regression estimate is about 0.97 times the standard error of the unweighted estimate. The difference is due to the fact that

$\sum^n w_t^2$ is consistently bigger than n^{-1} because the sample is unbalanced on a number of items.

Table 6 also contains the estimated differences between the unweighted and weighted estimators of the mean. The difference between the unweighted and the weighted estimated mean is

$$\sum_{t=1}^{n} Y_t/n - \sum_{t=1}^{n} a_t Y_t = \sum_{t=1}^{n} (1/n - a_t) Y_t ,$$

where $a_t = w_t / \sum^n w_s$.

To compute the variance of the difference between the means, we note that the hypothesis of a zero difference is equivalent to the hypothesis that the correlation between a_i and y_i is zero. Therefore, using PC CARP, we computed the unweighted regression of y_i on a_i and computed the variance of the regression coefficient under the design. The standard errors for the difference in table 6 are such that the "t-statistic" for the hypothesis of zero difference is equal to the "t-statistic" for the coefficient of a_t in the regression of y_t on a_t.

For all three characteristics, the difference between weighted and unweighted estimators of the population mean is significant at traditional levels. Thus, under the assumption that the regression estimators are unbiased, there are significant biases in the unweighted estimators. We do not know that the regression estimator is unbiased, but it seems reasonable to assume that the regression adjustment reduces the bias in the estimators of the population mean.

The last column of table 6 contains the ratio of the estimated mean square error of the unweighted estimator to the variance of the regression estimator. The estimated mean square errors for the unweighted estimators were computed as

$$\hat{MSE}_u = \hat{V} + \max \{0, (\text{Diff})^2 - (\text{s.e. diff})^2\}$$

where $\hat{V}$ is the estimated variance of the unweighted estimate, Diff is the difference between the two estimates from table 6, and s.e. diff is the standard error of the difference from table 6. The second term of the estimated mean square error is the estimated squared bias. The estimated mean square errors of the weighted estimators are the variances of the weighted estimators computed as the squares of the standard errors of table 6.

Of the three characteristics for which the population mean was estimated, the estimated relative efficiency of the regression estimator to the simple mean ranges from 2.5 to 129. The regression estimator for meals away has the smallest estimated efficiency. The variances of the two estimators are similar, but because of the estimated bias, the regression estimate for meals away is estimated to have a mean square error that is about (1/2.5 =) 40 percent of that

of the unweighted estimate. The mean square error of the regression estimate for home food is less than 20 percent of that of the unweighted estimate, and that for meal persons is about 1 percent of that of the unweighted estimate. In all cases, the squared bias is a very important component of the estimated mean square error.

Even after allowing for the fact that the population totals from the Current Population Survey are not known population totals, it is clear that, for these items, large gains in accuracy are associated with regression estimation for the population means.

Individual Data

Weight construction—The data set for individuals providing day 1 dietary intakes consists of 10,172 persons. The 8,468 persons providing 3-day dietary intakes are a subset of the 10,172 individuals who provided 1-day intakes.

For both individual data sets, weights were constructed separately for each of three sex-age groups; namely, men age 20 and over, women age 20 and over, and persons under 20 years old. There are 3,158 observations for the men, 3,967 observations for the women, and 3,047 observations for persons less than 20 years old in the day 1 data set. There are 2,619 men, 3,293 women, and 2,556 persons under age 20 in the 3-day data set.

The 13 characteristics in table 3 (see chapter 2) were converted to indicator variables that could be used in a regression analysis. Using this procedure on the 13 characteristics resulted in 20 control variables for the men, 20 for the women, and 19 for those under 20 years old (the latter group having one less age category).

In addition, control variables were created for day-of-observation and month-of-observation by race (black, nonblack) for each of the three sex-age categories. Twelve control variables were created for the day effects (6 for nonblack and 6 for black) and 22 were created for the month effects (11 for nonblack and 11 for black) for each sex-age group. In all, there were 54 control variables each for the men and women and 53 control variables for those less than age 20. The population totals for the day and month effects were calculated by dividing the population total for each race by 7 and 12 for each sex-age group.

The weights were greatly influenced by the distribution of observations over day of the week and month. For the day 1 sample, the number of Saturday observations is well below that expected under an even distribution of observations over day of the week (table 8). Overall, the sample contained 4.7 percent Saturday observations, whereas 14.3 percent was expected. Black men had the lowest fraction of Saturday observations, 3.5 percent. The uneven distribution of observations over day of the week can be explained by the lack of interviewers working on Sundays. In a Sunday interview, the first day of observation is the Saturday information collected by recall.

There was also an uneven distribution of observations over months, which was partly due to the fact that the data were collected over a 17-month period. Nearly 70 percent of the observations for the day 1 sample were taken during the 6 months of January through June; over half of the observations were obtained during the 4 months of March through June. The distribution of observations over months was similar for the three sex-age groups.

The weights for the 3-day sample were influenced by the distribution of observations over day of the week and month in the same fashion as the day 1 sample weights. The day of the week on which the first day of the 3-day observation period was conducted was used as the control variable in constructing weights for the three-day sample.

The weight program was applied separately to each of the three sex-age groups. Constant starting weights were used for the weight generation program for each group. The iterations within the program are designed to produce weights which are all nonnegative and such that the largest weights are not overly large relative to the average weight. The program then rounds the real weights to integer weights, so that the sum of the integer weights is the population total in thousands. Iteration is used to construct integer weights such that the maximum deviation between the estimated and actual population totals was five (that is, 5,000).

The mean weights are 25.1, 22.3, and 23.4 for men, women, and persons under age 20. The largest weight for males is 5.18 times the mean weight for men. The analogous ratios for women and persons under 20 are 3.50 and 5.81. The weights range from 1 to 136 for the 10,172 observations. Two individuals had a weight of 136 and 11 had a weight of 1. The ranges of the weights are from 1 to 130 for men, from 1 to 78 for women, and from 1 to 136 for persons under 20. The ratios of the mean of the squared weights to the mean of the weights squared are 2.50, 2.13, and 2.42 for men, women, and persons under age 20.

Table 8.--Temporal distributions for day 1 and 3-day samples

Characteristic	Day 1 sample percentage	3-day sample percentage	Target percentage
(a) Men age 20 and over			
Day of week:			
Sunday	20.3	20.6	14.3
Monday	17.5	17.1	14.3
Tuesday	17.6	17.2	14.3
Wednesday	15.3	15.7	14.3
Thursday	13.3	13.5	14.3
Friday	11.6	11.5	14.3
Saturday	4.5	4.4	14.2
Month:			
January	8.2	8.3	8.3
February	8.3	8.9	8.4
March	12.2	11.7	8.3
April	11.0	10.8	8.3
May	17.5	17.5	8.3
June	12.8	12.3	8.4
July	3.6	3.1	8.3
August	3.4	3.5	8.4
September	6.7	7.5	8.3
October	7.0	6.8	8.3
November	3.2	3.3	8.4
December	6.1	6.2	8.3
(b) Women age 20 and over			
Day of week:			
Sunday	20.0	20.3	14.3
Monday	18.1	18.3	14.3
Tuesday	17.0	16.9	14.3
Wednesday	15.6	15.9	14.3
Thursday	13.0	12.7	14.3
Friday	11.9	11.8	14.3
Saturday	4.4	4.2	14.2
Month:			
January	8.8	8.9	8.3
February	8.2	8.6	8.4
March	11.6	11.4	8.3
April	10.5	10.3	8.3
May	17.5	17.3	8.3
June	12.9	12.3	8.4

Continued

Table 8.–Temporal distributions for day 1 and 3-day samples—continued

Characteristic	Day 1 sample percentage	3-day sample percentage	Target percentage
(b) Women age 20 and over			
July	4.3	3.5	8.3
August	3.6	3.6	8.4
September	7.2	7.0	8.3
October	6.6	7.0	8.3
November	3.1	3.2	8.4
December	5.8	6.0	8.3
(c) Persons under 20 years old			
Day of week:			
Sunday	18.6	18.2	14.3
Monday	17.7	17.9	14.3
Tuesday	17.9	18.1	14.3
Wednesday	15.1	15.7	14.3
Thursday	13.6	13.7	14.3
Friday	11.8	11.3	14.3
Saturday	5.2	5.2	14.2
Month:			
January	9.5	9.6	8.3
February	8.7	9.2	8.4
March	11.7	11.7	8.3
April	11.8	11.2	8.3
May	16.1	16.4	8.3
June	12.1	11.3	8.4
July	4.0	3.4	8.3
August	3.2	2.9	8.4
September	7.6	8.4	8.3
October	6.3	6.4	8.3
November	3.4	3.6	8.4
December	5.6	5.8	8.3

A procedure similar to that used on the day 1 data set was used to find regression weights for the 3-day data set. Of the 8,468 subjects in the 3-day sample, 2,619 were men age 20 and over, 3,293 were women age 20 and over, and 2,556 were persons under age 20. The same 54 control variables were used on each of the three sex-age groups in constructing weights via the weight generation program. Rather than using constant starting weights, however, the final weights found for the day 1 survey subjects who participated in the 3-day study were used as starting weights for the 3-day sample.

The means of the weights for the 3-day data are 30.3, 26.8, and 27.9 for men, women, and persons under age 20. The means of the squares of the weights are 2.54, 2.19, and 2.71 times the mean weight squared for men, women, and persons under 20. These ratios are slightly larger than those for the day 1 weights. A slight increase would be anticipated because the same number of control variables are being used on a smaller sample. Each control variable imposes a restriction on the weights. The weights for the 3-day data range from 1 to 231 for men, 1 to 142 for women,

and 1 to 259 for persons under 20. The largest weights are 7.62, 5.30, and 9.28 times the mean weight for men, women, and persons under age 20. These ratios are also larger than the corresponding ratios in the day 1 data set for the same reason.

Efficiency comparisons—The day 1 sample was used to compare the efficiency of the regression estimator with that of the simple estimator. The following variables were used in the comparison:

Y_1 = indicator to identify pregnant/lactating women (nurse)
Y_2 = food energy intake as percentage of Recommended Dietary Allowance (%RDA)
Y_3 = total fluid milk intake (milk)
Y_4 = total food energy intake (energy)
Y_5 = away from home food energy (energy out)

The means and standard errors for the unweighted estimates were computed in PC CARP, recognizing that the sample is a stratified cluster sample. As was the case with the household data, the estimated variances are larger than the variance of a simple random sample containing the same number of individuals. This is due to the correlations among elements within clusters. The estimated design effects are shown in table 9.

Table 9.–Design effects of unweighted means for selected individual variables

Variable	Men age 20 and over	Women age 20 and over	Persons under age 20
Nurse	NA	1.3	0.9
%RDA	2.7	1.7	2.5
Milk	2.0	1.5	2.2
Energy	2.8	1.8	2.5
Energy out	1.8	1.7	3.0

The means of the variables computed using unweighted data are given in table 10 in the column headed "Unweighted mean." Means for the five variables are given for each of the three sex-age groups: men, women, and persons under age 20. The standard errors are given in parentheses below the estimates. In table 10, estimates computed using the regression weights are given in the column headed "Weighted mean." The standard errors were computed in PC CARP using the formula for the regression estimator. The variance calculation requires computing a regression for each variable. The standard errors of the weighted and unweighted estimates for these individual characteristics generally differ more than did the standard errors for the household characteristics, and in every case the standard error of the weighted estimate exceeds that of the unweighted estimate. These characteristics were not highly correlated with the variables used as controls in the regression procedure.

Table 10.--Properties of alternative estimators for selected individual variables

Variable	Unweighted mean	Weighted mean	Difference	Relative efficiency of regression
		Men age 20 and over		
%RDA	78.57 (1.00)	79.80 (1.29)	-1.23 (0.95)	0.96
Milk	192.07 (7.73)	201.56 (10.48)	-9.49 (7.36)	.87
Energy	2,100.00 (27.59)	2,153.97 (35.52)	-53.97 (26.27)	2.37
Energy out	471.36 (17.86)	570.44 (33.52)	-99.08 (23.70)	8.52
		Women age 20 and over		
Nurse	3.58 (0.34)	3.90 (0.45)	-0.32 (0.27)	.72
%RDA	71.43 (0.63)	71.25 (0.96)	0.18 (0.59)	.43
Milk	153.32 (4.25)	147.77 (5.37)	5.56 (3.36)	1.30
Energy	1,493.05 (13.58)	1,497.01 (20.38)	-3.96 (12.38)	.44
Energy out	303.95 (10.61)	339.04 (12.95)	-35.09 (8.95)	7.53
		Persons under 20 years old		
%RDA	85.20 (0.97)	85.27 (1.14)	-0.07 (0.96)	.72
Milk	343.42 (8.76)	340.89 (12.77)	2.52 (11.34)	.47
Energy	1,669.44 (22.95)	1,707.97 (26.40)	-38.53 (24.32)	2.04
Energy out	411.53 (18.68)	441.56 (20.97)	-30.03 (20.83)	1.86

The estimated multiple correlations between the variables in table 10 and the control variables ranged from 0.03 (%RDA for women) to 0.26 (energy for persons under age 20). If the sample means and the population means for the control variables had been nearly equal, the variance of the regression estimate of %RDA for women would have been about (1 – 0.03) = 0.97 times the variance of the unweighted estimate. For energy for persons under 20, the variance of the regression estimate would have been about (1 – 0.26) = 0.74 times the variance of the unweighted estimate. Actually, the estimated variance of the regression estimate is about 2.79 times the variance of the unweighted estimate for %RDA for women and about 1.32 times the variance of the unweighted estimate for energy for persons under age 20. The difference is due to the fact that the sample is unbalanced on a number of items, so that $\sum^{n} w_i^2 / n$ is considerably greater than $\bar{w}^2$ (2.14 times as large for women, 2.49 times for men, and 2.48 times for persons under age 20).

Significant differences between the weighted and unweighted estimated means were found for energy out for women, and for energy and energy out for men. In addition, as is shown in the last column of table 10, the estimated relative efficiency of the regression estimator was greater than 1 for milk for women, and for energy and energy out for persons age 20 and under.

As was the case with the household data, substantial gains can be achieved with regression estimation for the population means. But gains are not assured, as table 10 illustrates. Losses in efficiency, when they do occur, are generally small relative to the gains in efficiency for other variables. The estimated low efficiency for the regression estimator in the cases of %RDA and energy for women, and milk for persons under age 20 are a result of the relatively small estimated biases in the unweighted estimates.

Chapter 4: Comparison of Results With Other Surveys

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Chapter 2 showed that the original NFCS 1987-88 respondent sample was unbalanced with respect to a number of demographic characteristics. The weights described in chapter 3 were designed to make the weighted estimates of the control characteristics equal to the known control totals. If the control characteristics are correlated with the items of interest, the weighting will reduce the bias associated with the original nonresponse. One cannot make a direct evaluation of the remaining potential nonresponse bias; however, one can obtain some indirect information by comparing the weighted estimates from NFCS 1987-88 with estimates from other surveys having higher response rates and sampling the same (or similar) target population. Three types of surveys were considered:

(1) contemporaneous surveys that contain similar or identical sociodemographic variables but have no information on food intake,

(2) contemporaneous surveys that contain similar or identical sociodemographic and health-related variables and limited information on food intake, and

(3) past surveys that contain sociodemographic and food intake variables that are identical or very similar to those in NFCS 1987-88.

A survey of the first type is the 1987 Current Population Survey (CPS), which was used to determine population characteristics, compare them with the unweighted NFCS sample (chapter 2), and construct the weights (chapter 3).

A survey of the second type is the 1987 National Health Interview Survey (NHIS), Cancer Risk Factor Supplement, Epidemiology Study, conducted by the U.S. Bureau of the Census for the National Center for Health Statistics, DHHS (14). The NHIS contains several sociodemographic and health-related variables that are identical or very similar to those of the NFCS. In addition, the NHIS contains a few frequency-of-food-intake variables that are similar to the NFCS food-frequency variables.

Three surveys of the third kind, all conducted by the U.S. Department of Agriculture, are available. These are--

- the 1985 Continuing Survey of Food Intake by Individuals (CSFII 1985), which included the collection of dietary and other data on women 19 to 50 years of age, their children 1 to 5 years of age, and men 19 to 50 years of age;
- the CSFII 1986, which was similar to the 1985 survey except that it did not include men; and
- the 1977-78 Nationwide Food Consumption Survey (NFCS 1977-78).

Current Population Survey

The estimates of population distributions of six demographic variables not used as controls when creating the NFCS weights were compared using the 1987 CPS and NFCS 1987-88 weighted day-1 data for individuals. The variables were examined for how similar the NFCS estimates were to the CPS estimates overall (table 11), and for three subgroups: men 20 years of age and over, women 20 years of age and over, and persons under 20 years of age.

The variables compared were--

- Persons living in households with a given education level of the male head of household (highest grade completed)
- Persons living in households with a given education level of the female head of household (highest grade completed)
- Geographic location of household (Census geographic division)
- Household size

- Ethnic origin (Spanish/Hispanic or not; or not reported)
- Race of individual, including "other," a category not used in the weighting.

Results indicated that the weighting strategy used for the NFCS was effective in making the individual intake data representative of other population characteristics. For three variables--education level of the male head, household size, and race--NFCS and CPS percentages were quite similar, with the majority of categories only differing by no more than 2 percentage points (table 11). For the other three variables there were a few differences, but these tended to be limited to certain categories of those variables--13 years or more education for persons living in households with a female head of household, Mountain and Pacific States where the differences in one direction offset those in the other, and Hispanic origin, where differences of about 5 percent may be due to differences in wording. CPS respondents selected their Spanish ethnic origin from a flash card listing eight categories (Mexican, Cuban, etc.). NFCS household respondents were asked by the interviewer if anyone in the household was of Hispanic origin or descent (a two-choice answer).

Table 11.--Comparison of distributions of population characteristics of individuals from weighted NFCS and the CPS

Characteristic	NFCS	CPS	| Difference |
	----------percent----------		
Education level of male head:			
None	0.1	0.4	0.3
1-8 years	7.6	9.0	1.4
9-11 years	10.3	9.0	1.3
12 years	28.4	29.5	1.1
13+ years	34.8	33.5	1.3
No male head	18.8	18.6	.2
Education level of female head:			
None	.1	.4	.3
1-8 years	7.2	8 .8	1.6
9-11 years	10.4	11.4	1.0
12 years	38.7	40.5	1.8
13+ years	37.6	31.0	6.6
No female head	5.9	8.0	2.1
Geographic division:			
New England	5.9	5.3	.6
Middle Atlantic	14.9	15.5	.6
East North Central	17.6	17.4	.2
West North Central	7.1	7.3	.2
South Atlantic	17.9	17.0	.9
East South Central	4.4	6.3	1.9
West South Central	11.9	11.0	.9
Mountain	9.0	5.4	3.6
Pacific	11.2	14.9	3.7
Household size:			
1 person	9.1	9.0	.1
2 persons	24.4	24.2	.2
3 persons	21.2	20.5	.7
4 persons	24.2	23.6	.6
5+ persons	21.0	22.8	1.8

Continued

Table 11.--Comparison of distributions of population characteristics of individuals from weighted NFCS and the CPS—continued.

Characteristic	NFCS	CPS	| Difference |
	percent		
Ethnicity:			
Hispanic	4.3	7.8	3.5
Non-Hispanic	95.4	90.5	4.9
Not reported	.3	1.7	1.4
Race:			
White	82.9	84.7	1.8
Black	12.2	12.2	.0
Other	4.9	3.1	1.8

Overall, the scattered differences do not seem widespread enough to suggest a systematic pattern covering all variables investigated or affecting all comparisons made for a particular subgroup of sampled persons.

National Health Interview Survey

The 1987 NHIS Cancer Risk Factor Supplement had an overall response rate of about 82 percent (15). The supplement design incorporated a split sample; about half of the 44,123 repondents were included in the Epidemiology Study. Because of the higher response rate in the 1987 NHIS study, nonresponse bias is considerably less likely than in NFCS 1987-88. Some questions on sociodemographic and health variables were asked in an identical, or very similar, manner in both surveys, making some direct comparisons possible. Food frequency data available from the two surveys were also examined. Population estimates using weighted data from NFCS and NHIS were compared.

Nine sociodemographic variables were considered similar enough in the two surveys for comparison: region, urbanization, age, race, ethnic origin, household income, education of the household head, employment status, and living alone. The estimated percentage of the population that was living in each of the four census regions was nearly identical--about one-fifth of the sample in each survey lived in the Northeast, another one-fifth in the West, one-fourth in the Midwest, and one-third in the South. The estimated mean levels of several characteristics were in fairly close agreement between the two surveys: age (figure 1), employment status (figure 2), household income expressed as a percentage of the Federal poverty level, and education level of the household head. For other characteristics, there was less agreement between the estimated means from the two surveys. Fewer men (figure 3) and women 18 years old and over lived in central cities, and more lived in suburban and nonmetropolitan locations, according to NFCS estimates compared with NHIS estimates. NHIS estimates showed more individuals living alone (figure 4) than did NFCS; the NFCS estimates are closer to the CPS population estimates than the NHIS estimates are. According to both NFCS and NHIS, blacks made up about the same proportions of the total population (10 percent for men and 12 percent for women). For the total population and in all regions, the NFCS apparently underestimated the proportion of individuals of Hispanic origin; the NHIS estimates were close to the CPS estimates.

The estimated mean levels for self-reported height (figure 5), weight (figure 6), and body mass index were nearly identical in NFCS 1987-88 and the NHIS 1987, as were the percentages of individuals reporting health status as good, very good, or excellent. However, the NFCS estimate shows a smaller percentage of men and women taking vitamin and mineral supplements than does the NHIS (figure 7). Also, the NFCS estimates showed lower percentages of men and women who have quit smoking (figure 8), but higher percentages that never smoked.

In NFCS 1987-88, participants were asked questions pertaining to frequency of consumption of 11 calcium-rich foods over the last 3 months. In NHIS 1987, participants were administered a food frequency questionnaire containing approximately 60 food items. Participants were asked about their frequency of consumption over the past year. To make the responses as comparable as possible, the NFCS results were multiplied by four to give an estimate of frequency of consumption over the past year.

Six food frequency questions were similar enough across the two surveys to allow comparison. There was close agreement only for women's consumption of cheese, although estimated cheese intake by women in the West was higher in the NFCS 1987-88 than in the NHIS 1987 (figure 9). Milk as a beverage, milk in coffee/tea, ice cream (figure 10), and dry beans (figure 11) showed less agreement for both men and women. Consumption of dark-green leafy vegetables was dramatically different (figure 12). As in the case of the sociodemographic and health characteristics, most of the differences in the average food frequency levels were in the same direction across sex and region classifications.

Food frequency differences may be attributable to methodological differences between the two surveys, including the different lengths of the recall periods (past 3 months in NFCS versus the past year in NHIS) and differences in the wording and context of the questions. For example, the context of the frequency of consumption of dark-green leafy vegetables question differed in the two surveys. In NFCS, this question was not preceded by any salad or vegetable questions, but in NHIS it followed the question about salad consumption. It seems likely that some NHIS respondents may have included dark-green leafy vegetable consumption in their answers to the salad question, or some NFCS respondents may have included lettuce in their dark-green leafy vegetable answer. Either would have contributed to the large differences in the estimated mean frequencies of dark-green leafy vegetable consumption between the two surveys.

Because of these methodological differences, it is difficult to judge whether the NFCS variables that had different estimated mean levels from those of the NHIS were subject to nonresponse bias. On the other hand, it is reassuring that several of the NFCS and NHIS variables had nearly identical estimated mean levels for the population.

Previous USDA Surveys: 1977-78, 1985, and 1986

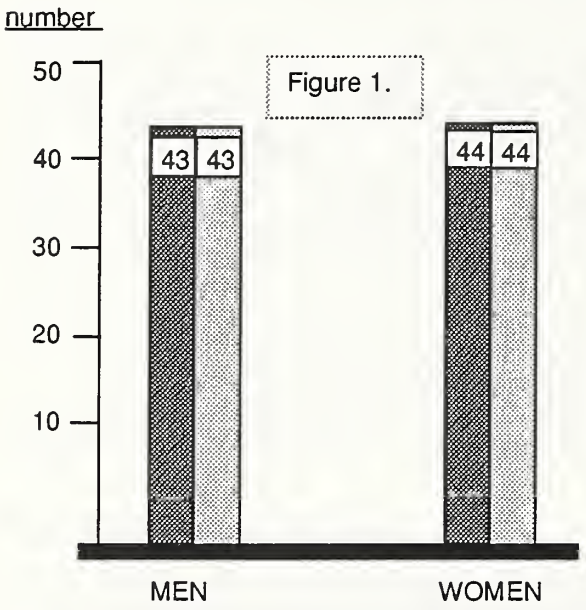
The nonresponse evaluation included a comparison of food energy from NFCS 1987-88 with previous surveys conducted by USDA--the 1977-78 Nationwide Food Consumption Survey and the Continuing Surveys of Food Intakes by Individuals conducted in 1985 and 1986 (figure 13). Although these surveys had different methodologies, designs, and target samples, all four surveys included a 24-hour recall of dietary intake in April and May; the comparisons were limited to these data. In addition, since the CSFII 1985 and 1986 targeted only specific sex-age groups, the comparisons were limited to children 1 to 5 years old and women 19 to 50 years old.

Many factors may have contributed to the differences between estimated food energy for 1977-78, 1985, 1986, and 1987-88, including (1) true differences in population intakes, (2) sampling error, (3) differences in the weighting procedures used, (4) differences in respondent burden caused by the presence or absence of the household component of the survey, (5) artifactual changes in the food composition data base resulting from improvements in food sampling and analytical techniques and larger sample sizes (16), and (6) nonresponse bias.

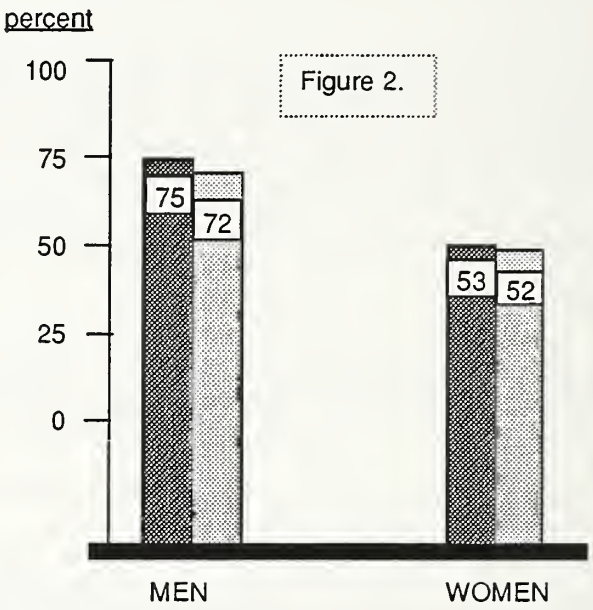
The purpose of the analysis was to seek evidence of nonresponse bias; however, the differences that were found appear to have been caused by the differences in methodology, design, and target samples rather than by nonresponse. The estimates from the two Nationwide Food Consumption Surveys were generally more similar to each other than they were to estimates from the two CSFII's. These estimates most likely reflect the differences in respondent burden between NFCS and CSFII.

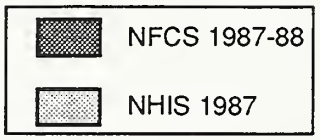
Figures 1-4.--Comparisons of selected sociodemographic variables in NFCS 1987-88 and NHIS 1987

Age (Years)
Individuals 18+ years of age

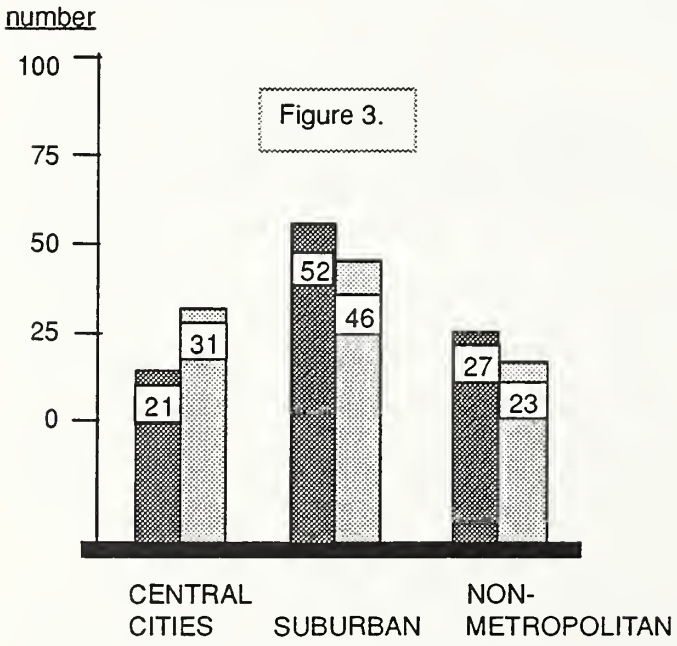


Employment--Worked last week (NFCS)
or last 2 weeks (NHIS)
Individuals 18+ years of age

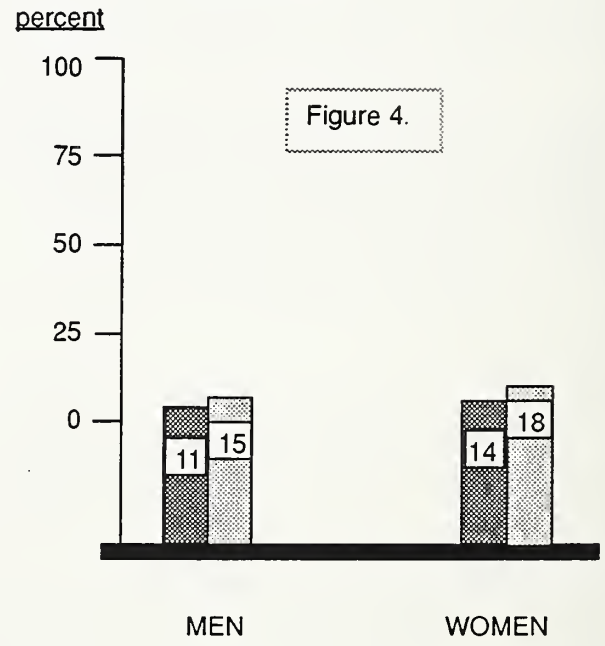




Urbanization
Men 18+ years of age

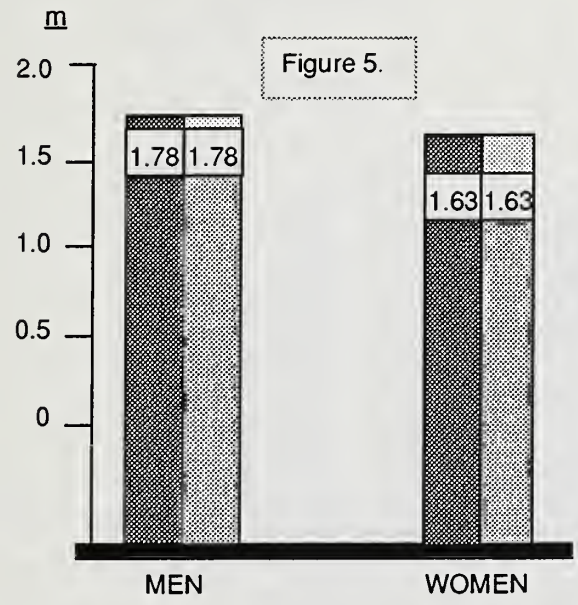


Living Alone
Individuals 18+ years of age

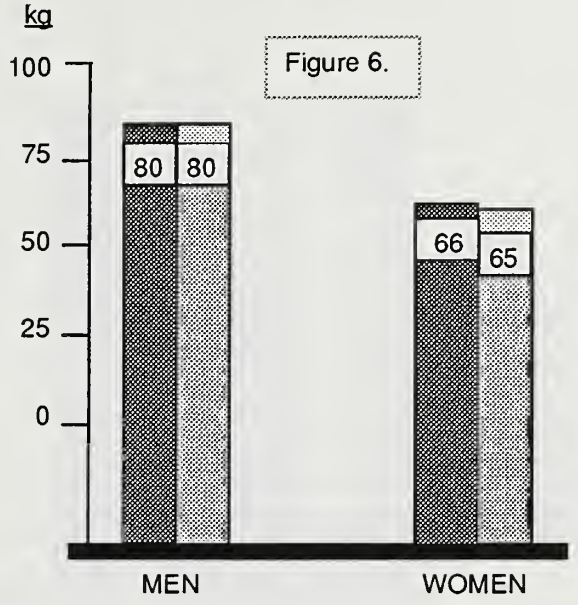


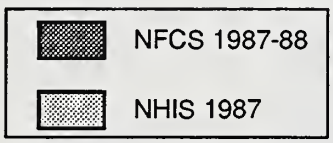
Figures 5-8.--Comparison of health variables in NFCS 1987-88 and NHIS 1987

Self-reported height
Individuals 18+ years of age

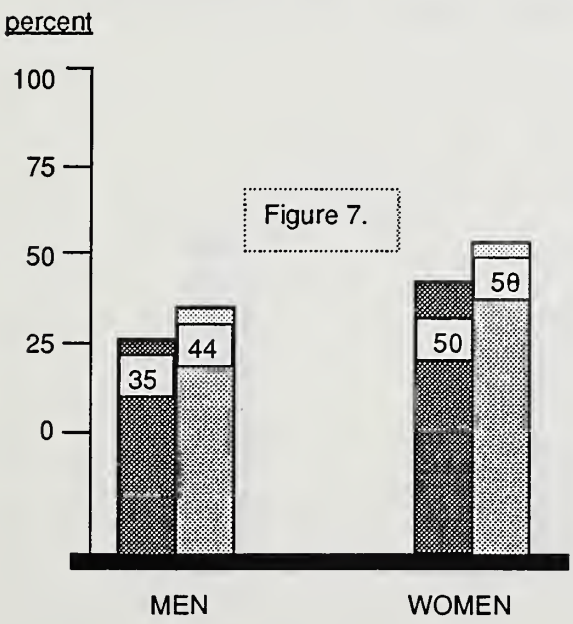


Self-reported weight
Individuals 18+ years of age

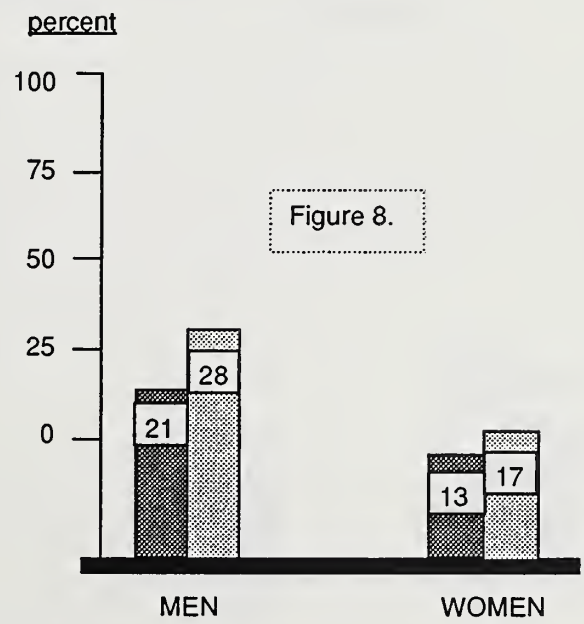




Vitamin and mineral supplements
Individuals 18+ years of age



Smoking
Individuals 18+ years of age



Figures 9-12.--Comparisons of selected food frequency variables in NFCS 1987-88 and NHIS 1987 (number of times consumed per year), individuals 18+ years of age

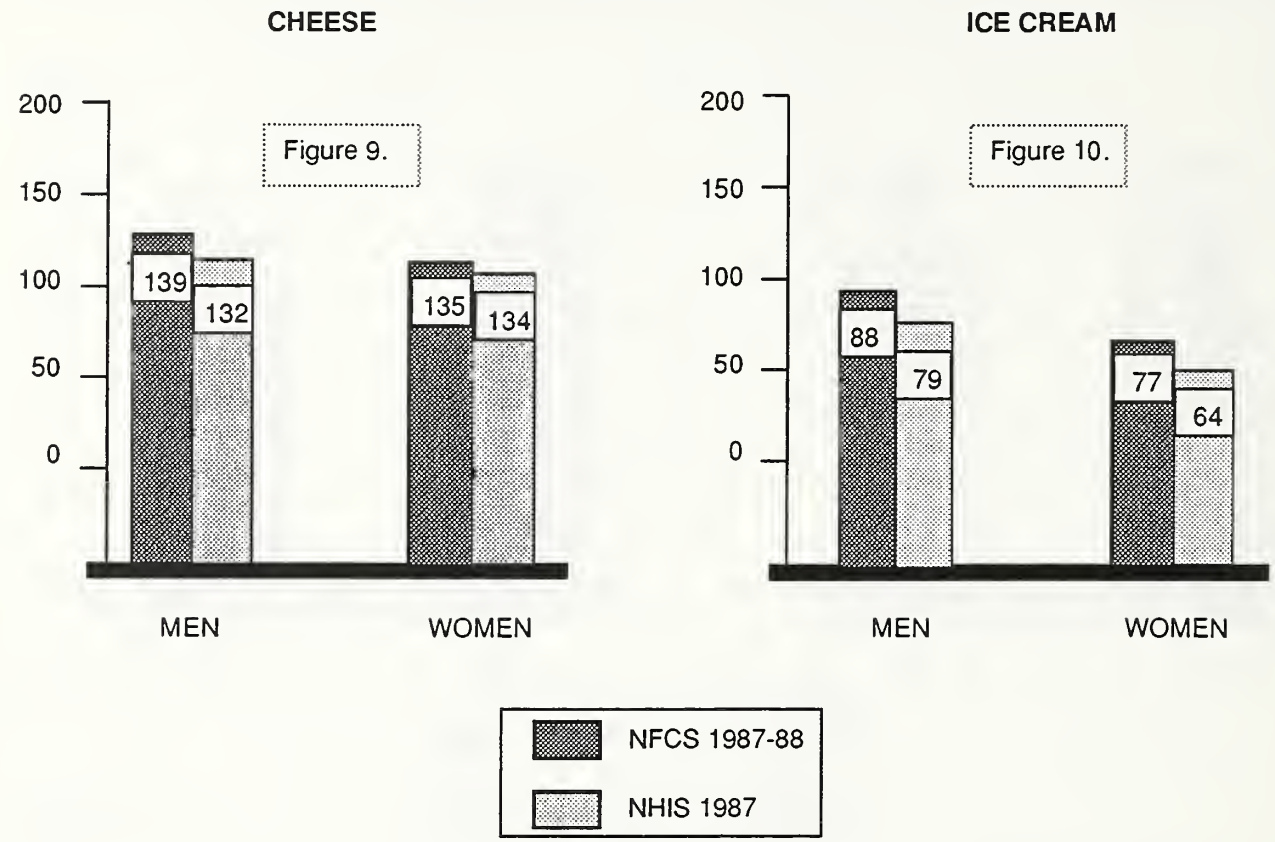
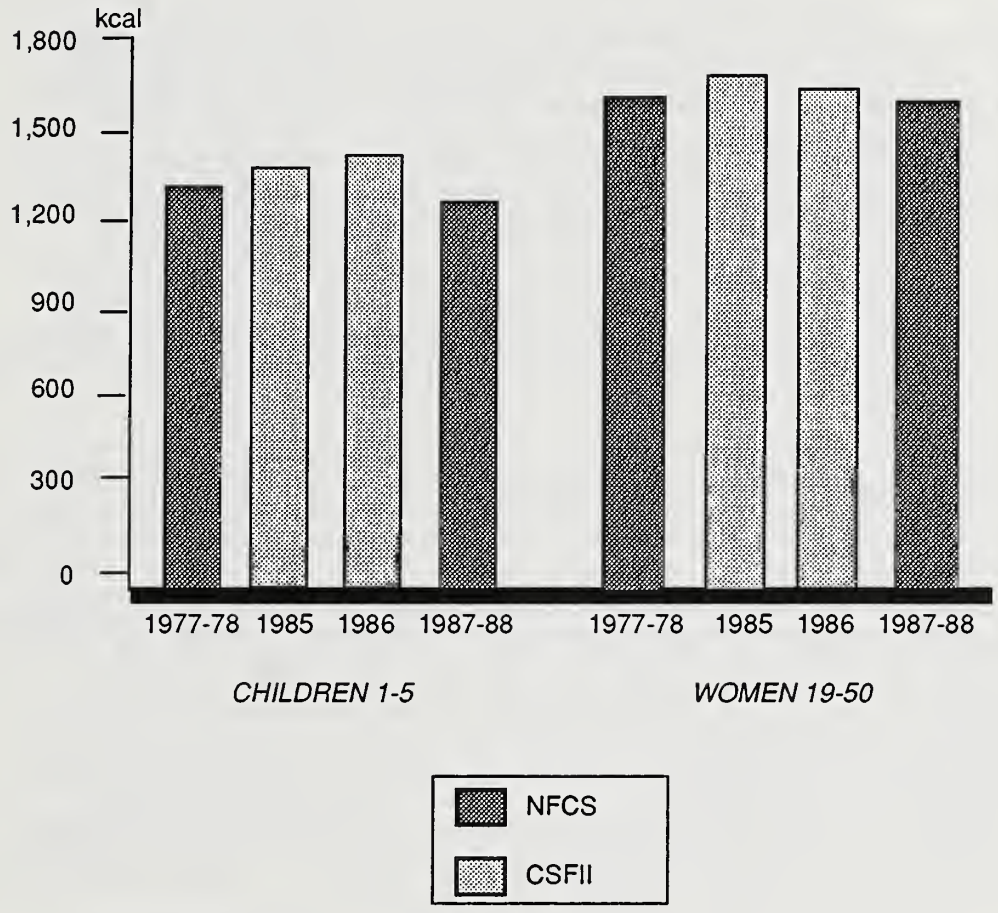


Figure13.--Estimated food energy intakes from four USDA surveys, 1 day, April and May



Chapter 5: Intrasurvey Comparison

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Households drawn into the NFCS 1987-88 sample participated to varying degrees. Some households completed all three components: the household survey, the 1-day recall, and the 2-day record. However, a large number of households that participated in the household component had individual household members who declined further participation in the individual intake components or provided only 1 day of recall data. The purpose of this study is to determine if there was an association between level of household participation and dietary quality. Can the conclusions regarding individual intake of the full participants be generalized to those respondents in households that discontinued participation at an earlier point? Alternatively, is there bias with regard to level of participation?

Investigating the effects of the level of participation within a given sample falls into a general class of methods of nonresponse analysis that incorporate the use of a nonparticipating internal criterion group to compare to full participants to determine if the groups are similar (17, 18, 19, 20, 21). The sources of this criterion group are diverse, but the basic requirements are (1) the data from this group must be obtained in the same manner as the data from the full participants and (2) there must be a justification of why this criterion group may represent nonrespondents.

The households that dropped out before the completion of all survey components fulfilled these requirements. The information from them was obtained using the same methodology, design, and target sample as the full participants. This is an important quality since differences in these factors between NFCS 1987-88 and other surveys used for comparison were a confounding limitation common to the other nonresponse studies included in this report.

There is also reason to believe that this nonparticipating group may be more similar to survey nonrespondents than are the fully cooperating participants. The universal characteristic shared by this group and nonrespondents was their propensity to refuse participation, even if it was at different points in the survey administration. Refusal was a major source of complete nonresponse in the NFCS 1987-88 (table 1), and it was also the primary reason cited for discontinued participation (22); therefore, the households that dropped out before the completion of all survey components can be used to detect nonresponse bias with regard to level of participation. Also, there is potential for extending their use as proxies for total nonrespondents, at least with regard to refusals, although possibly not for noncontacts. There is reasonable support in the literature to the effect that proxies obtained by various means adequately represent refusals. However, noncontacts have been shown to be distinctly different in many relevant characteristics from participants and from refusals as well (21, 23, 24, 25, 26, 27), and noncontacts were high in this survey. For this reason, extrapolation of results to all nonrespondents is not advisable.

The research included the following steps: First, since the household was the unit of analysis, individuals were classified at the household level; and the validity of that classification was determined. Second, a preliminary analysis was performed to detect differences among the groups in sociodemographic factors that are related to food consumption and dietary intake (4, 5, 6, 7). Third, two statistical tests of differences between levels were performed: (1) a multiple analysis of variance (MANOVA) with dietary quality as the dependent variable and level of participation as the grouping variable to determine if nonresponse bias was present with regard to participation, and (2) a multiple analysis of covariance (MANCOVA) to determine whether controlling for those factors associated with dietary quality that were found to be dissimilar among the levels of participation would effectively nullify the bias by eliminating the differences observed between the levels on the variable of interest. The significance of these specific variables in detecting bias could merely be an artifact of this particular sample. Unweighted data were used for the analyses because we sought assessment of effects of nonresponse prior to adjustments.

Classification of Households

All households included in this analysis provided satisfactory household-level information. A total of 4,589 households were available for this study; however, 316 households were unusable because no member of the household had 10 or more meals from the household food supply so there was insufficient information available to determine household

food use. Another 31 households were excluded because the patterns of individual participation in those household were too mixed to categorize them into a level as defined by the decision rules set forth. As a result, 92 percent of the available sample was utilized (table 12). The remaining 4,242 households were divided into three levels:

(1) Level 1: Fully participating (3,195 households). At least half of the individuals in each of these households completed the 1-day recall and at least 1 day of the 2-day record. Respondents giving 2 days of individual intake were grouped with 3-day respondents because they did participate in the self-administered component of the survey even if only to a limited extent.

(2) Level 2: 1 day of individual participation (479 households). At least half of the individuals in the household completed the 1-day recall.

(3) Level 3: No individual participation (568 households). Less than half of the individuals in each of these households supplied any acceptable individual intake information.

Table 12. Classification of households by level of participation, NFCS 1987-88

Type of household	Number	Percent	Cumulative percent
Level 1: Household component and 2 or 3 days of intake	3,195	69.6	69.6
Level 2: Household component and 1 day of intake	479	10.4	80.0
Level 3: Household component only	568	12.4	92.4
Intakes too mixed to classify	31	.7	93.1
Unusable household records	316	6.9	100.0
Total participating households	4,589		

When the same number of individuals participated at two different levels, the household was classified at the higher (more complete) level.

To validate that the individual response rate was accurately represented by household response, a cross-tabulation of household classification by actual participating level of all individuals in those households was performed. The cross-tabulation revealed that on the individual level, 92 percent of the individuals in the households in this study were correctly classified. In other words, 92 percent of the individuals completed the same number of days--none, one, or all--as most of the other individuals in the same household. This finding agrees with that found in the literature: most nonresponse occurs at the household level (28).

Preliminary Data Analysis

In this study, it was important to consider sociodemographic characteristics related to dietary quality when evaluating similarity of this variable among the three defined levels of participation. If differences in sociodemographic characteristics could solely explain discrepancies found between the levels, they could be used to predict performance differences on dietary quality.

Thirteen variables, similar but not identical to those used in weighting the household data, have been found to be linked with dietary quality (6, 7, 29, 30, 31, 32, 33, 34, 35). (Household weight variables had not yet been determined when this study was initiated.) These variables were analyzed for differences between the three groups. They were

region; degree of urbanization; last year's income; Food Stamp Program participation; presence of child in the household under 7 years of age; presence of child in the household 7 to 17 years of age; single/dual head(s) of household; household size; and female head's age, race, ethnic origin (Hispanic or not), education level, and employment status. Region and urbanization were assigned from information on the sampling frame. Income had been imputed for 596 households using an ordinary least squares procedure relating the household and personal characteristics available. For the 335 households having no female head, characteristics of the male head were used. No other variables had missing data.

Categorical variables were subjected individually to loglinear tests of independence against level of participation. Since multiple tests were performed, a Bonferroni adjusted significance level of .004 (.05/13) was applied. Continuous variables were tested by considering each in a one-way analysis of variance with level of participation as the grouping variable.

Results of the tests of differences among participation levels on these characteristics indicated that, with the exceptions of Food Stamp Program status and the ethnic origin and employment status of the female head, all variables were significantly different. However, it should be noted that the assumption of homogeneity of variances was violated. This condition threatens the validity of the test to detect real differences between groups. The two smaller groups, Levels 2 and 3, displayed consistently larger variances than the fully participating group (Level 1).

Definition of Dietary Quality

Two types of information on food that could be used to measure dietary quality were available in the NFCS: household food use over a 7-day period and food intake by individual household members for up to 3 days. The household food use data was the common information available for comparing the dietary quality of the three different participating levels. It is a plausible assumption to consider food used by households to be highly related to actual food intake of individuals in any given household; therefore, if households that dropped out have food use resembling that of the fully participating households, it is not unreasonable to expect their individual intakes to be similar to participants' intakes as well.

Measurement of a concept as complex as dietary quality by utilizing any single variable is difficult. Consequently, dietary quality was operationalized by determining the nutritive value of foods used by the household expressed as percentage of the Recommended Dietary Allowances (RDA) for 15 nutrients and food energy, adjusted for both the number of meals eaten away from home and the sex-age composition of the household. The RDA percentages were considered collectively in a multivariate analysis.

Statistical Tests

A multiple analysis of variance (MANOVA) was performed testing for differences in dietary quality by level of participation. A multiple analysis of covariance (MANCOVA) was then performed controlling for the characteristics found discrepant among the participating levels. All statistical tests were conducted using version 4.0 of SPSS-X (36).

Testing of assumptions for MANOVA indicated that while multivariate nonnormality did not appear to be a problem, the assumption of homogeneity of variance-covariance matrices of the three participating levels was violated due to the large discrepancies in size between the three groups. Bartlett's Box-M test revealed that it was not feasible to regard the variance-covariance matrices as homogeneous. The smaller groups--those that discontinued participation at some point--produced significantly larger variances and covariances. In this situation, the significance test is too liberal, and whereas the null hypothesis (of no difference) may be accepted with confidence if this is the outcome, findings of differences are questionable (37).

Visual inspection of the correlation matrix and Bartlett's test of sphericity were used to assess the validity of considering all dependent variables collectively in a multivariate framework. Both tests determined that the dependent variables were highly correlated. The average correlation between variables was 0.62.

The multiple analysis of variance test statistic (Pillai's Trace) showed that there were significant differences among the three groups on dietary quality when there was no adjustment of relevant factors ($p < .05$). Since the test statistic was

significant, level differences in mean intakes were interpreted by examining the univariate F-tests. The only univariate test that reached the adjusted level of significance was that for protein ($p < 0.05/15 = 0.003$).

The inequality of the variance-covariance matrices was also a problem in the MANCOVA. Bartlett's Box-M showed there was heterogeneity between the three groups with the two smaller groups, Levels 2 and 3, exhibiting significantly larger variances and covariances.

Results of the effects of the covariates revealed that they performed as expected. Small but significant contributions to prediction were noted both collectively in a multivariate framework ($p < 0.05$) and individually in the univariate tests as a result of their use ($p < 0.004$).

The effect of level on dietary quality was not significant ($p = 0.25$). Households with no individual intake, households with 1 day of intake, and households with 2 to 3 days of intake were indistinguishable on dietary quality when measured in terms of the Recommended Dietary Allowances of 15 nutrients and food energy derived from foods measured via household food use data and controlling for pertinent sociodemographic characteristics.

Conclusion

This study revealed that dietary quality differed among households participating at various levels in the NFCS 1987-88. However, when relevant sociodemographic characteristics were accounted for by controlling them in a MANCOVA, the differences disappeared as expected. These characteristics explained the disparities in dietary quality among the households participating at the various levels. While these results cannot be generalized with confidence to sample households that did not participate in the survey at all, they do support the use of this set of characteristics in the nonresponse adjustment.

Conclusions

The LSRO Expert Panel concluded, and HNIS concurs, that it is not possible, based on the information available, to establish the presence or absence of nonresponse bias in NFCS 1987-88. However, the likelihood of such bias cannot be disregarded. It is also not possible to determine objectively the extent to which nonresponse bias might influence interpretation of analyses using data from NFCS 1987-88. The panel concluded that between-group comparisons are possible but must be made with the recognition that the respondents may not be completely representative of the subgroups. The panel also concluded that use of the data for estimates of specific foods or food groups, estimates of upper percentiles of intake, or estimates of intakes of subgroups for which the cell size is small is particularly questionable (1). Although the panel focused specifically on the individual intake component of the survey, these cautions should be applied to the household component as well.

Although the possibility of nonresponse bias cannot be disregarded and the NFCS data have serious potential for error, the procedures used to weight the NFCS data have limited the potential for bias as much as possible. All surveys have strengths and weaknesses, and--while the weaknesses of the NFCS are potentially serious--this should not rule out use of the data. NFCS 1987-88 provides the only current data available on household and individual food consumption.

The analyses summarized in this report and elsewhere (38, 39, 40) suggest that NFCS 1987-88 provides better estimates of current dietary intake than does the NFCS 1977-78, which is often the only alternative. The potential nonresponse bias in NFCS 1987-88 introduces less distortion in estimates of current consumption patterns than does the use of data collected a decade earlier.

Individuals using NFCS 1987-88 must do so with the greatest caution and with a full understanding of its limitations. Reports of findings should mention the potential for nonresponse bias and include a statement of the response rates. Users should carefully balance their need and tolerance for error in their application against the limitations.

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APPENDIX

Impact of Nonresponse on Dietary Data from the 1987–88 Nationwide Food Consumption Survey

April 1991

Prepared for the

HUMAN NUTRITION INFORMATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

under

Purchase Order #43-3198-1-0154

LIFE SCIENCES RESEARCH OFFICE
FEDERATION OF AMERICAN SOCIETIES
FOR EXPERIMENTAL BIOLOGY
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IMPACT OF NONRESPONSE ON DIETARY DATA FROM THE 1987-88 NATIONWIDE FOOD CONSUMPTION SURVEY

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FOREWORD

The Life Sciences Research Office (LSRO), Federation of American Societies for Experimental Biology (FASEB), provides scientific assessments of topics in the biomedical sciences. Reports are based upon literature reviews and the scientific opinions of knowledgeable investigators engaged in work in specific areas of biology and medicine.

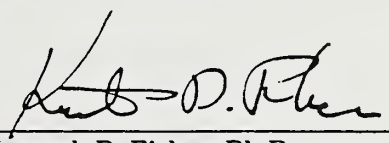
This report was developed for the Human Nutrition Information Service, U.S. Department of Agriculture, in accordance with the provisions of Purchase Order No. 43-3198-1-0154. It was prepared by an ad hoc Expert Panel convened by LSRO with the assistance of Sue Ann Anderson, Ph.D., Senior Staff Scientist and Kenneth D. Fisher, Ph.D., Director, LSRO. The members of the Expert Panel were chosen for their qualifications, experience, and judgment, with due consideration for balance and breadth regarding issues related to survey design and nonresponse. Members of the Expert Panel and others who provided information during the course of the study are listed in Chapter VIII.

This study was initiated in November 1990. The Expert Panel met in February 1991 to obtain background information on the 1987-88 Nationwide Food Consumption Survey conducted by HNIS and to assess the impact of a high rate of nonresponse on the dietary data from that survey. The Panel discussed each draft and the final report and provided additional documentation and viewpoints for incorporation into the final report. However, the LSRO accepts responsibility for the study conclusions and accuracy of the report; and the listing of these individuals in Chapter VIII does not imply that individual Panel members specifically endorse all statements in the report.

The final report was reviewed and approved by the LSRO Advisory Committee (which consists of representatives of each constituent society of FASEB) under authority delegated by the FASEB Board. Upon completion of these review procedures, the report was approved and transmitted to the Human Nutrition Information Service by the Executive Director, FASEB.

While this is a report of the Federation of American Societies for Experimental Biology, it does not necessarily reflect the opinion of each individual member of the FASEB constituent Societies.

April 26, 1991
Date



Kenneth D. Fisher, Ph.D.
Director
Life Sciences Research Office

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I. INTRODUCTION

A. BACKGROUND

The 1987–88 Nationwide Food Consumption Survey (NFCS) was conducted by the Human Nutrition Information Service (HNIS), U.S. Department of Agriculture (USDA), to provide data for estimates of food consumption by households and individuals in the 48 conterminous United States. The survey was designed as a self-weighting stratified area probability sample. The sampling units were households and individuals within sample households. The target sample was 6,000 households, projected to yield 15,000 individuals. Further details about the sample design are provided in Appendix A. The survey was conducted under contract for the HNIS by National Analysts of Philadelphia, Pennsylvania, a division of Booz, Allen and Hamilton, Inc.

Data collection for the survey was planned for a one-year period beginning in April, 1987. However, low response rates became evident in the first quarter of the survey, necessitating that adjustments be made to increase the sample size in subsequent quarters. As described in Appendix B, the size of sample draws was increased for the second, third, and fourth quarters and the data collection period was extended for a fifth quarter without an additional sample of households being drawn. Despite these efforts, the response rate was only about 38% for households in the survey and lower for individual participants in the sampled households (Appendix C).

The HNIS examined the available information on food consumption and sociodemographic characteristics of participants and conducted statistical analyses to explore the impact of the nonresponse on the estimates based on these data. In addition, the HNIS requested that the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) conduct an independent review of the impact of nonresponse on estimates of food and nutrient intakes based on the data from the 1987–88 NFCS and to make recommendations about possible uses of the data. LSRO convened an ad hoc Expert Panel consisting of statisticians with expertise related to survey design and nonresponse issues to assess the effects of nonresponse in the 1987–88 NFCS. These individuals are listed in Chapter VIII. This report summarizes the analysis of the nonresponse issues by the LSRO ad hoc Expert Panel.

B. SCOPE OF WORK

In the Scope of Work for this study, the HNIS specified that the following tasks be performed with respect to the 1987–88 NFCS:

- examine the statistical design and survey execution with particular emphasis upon issues related to nonresponse;
- review analyses on nonresponse conducted by the HNIS;
- identify additional analyses needed to evaluate further the potential for nonresponse bias in the NFCS; and,
- prepare a report that summarizes the findings of the above reviews and identifies critical issues relating to the implications of potential nonresponse bias that the HNIS may consider for inclusion in formal publications of survey results and research analyses.

C. DEFINITION OF NONRESPONSE BIAS

Nonresponse bias is the difference between the true value of the quantity being estimated and the expected value of the estimate provided by the respondents to the survey. Nonresponse bias can be restated as the product of two terms: 1) the difference between the estimated value for the respondents and the nonrespondents and 2) the proportion of nonrespondents.

A technical presentation of nonresponse bias follows.

R and NR are symbols for response and nonresponse. To estimate the mean intake of a nutrient, $\overline{Y}$, the nonresponse bias would be the difference between $\overline{Y}_R$ and $\overline{Y}$, that is, $(\overline{Y}_R - \overline{Y})$, where $\overline{Y}_R$ is the mean intake of all respondents in the population.

If P(R) is the proportion of respondents in the population, then P(NR) = 1 − P(R) is the proportion of nonrespondents. Thus,

$$\overline{Y} = \overline{Y}_R\, P(R) + \overline{Y}_{NR}\, P(NR)$$

Hence, nonresponse bias is given by the expression

$$\overline{Y}_R - [\overline{Y}_R\, P(R) + \overline{Y}_{NR}\, P(NR)] = \overline{Y}_R\, [1 - P(R)] - [\overline{Y}_{NR}\, P(NR)] =$$

$$\overline{Y}_R\, P(NR) - \overline{Y}_{NR}\, P(NR) = [\overline{Y}_R - \overline{Y}_{NR}]\, P(NR).$$

II. SURVEY DESIGN AND EXECUTION

A. RESPONSE RATES AT DIFFERENT STAGES OF CONTACT WITH HOUSEHOLDS AND INDIVIDUALS

Information was provided by the HNIS about responses rates of households and individuals that was valuable for tracking the points at which nonresponse occurred (Appendix C).

The rate of failure to make initial contact was quite high (greater than 17%). Because call-back records were not kept consistently by all interviewers, further evaluation of this problem was not possible. The rate of refusal to participate in screening (14%) was not unusual; however, the rate of refusal by those screened to participate in the interviews (45%) was extremely high. In contrast, in the 1986 CSFII, about 25% did not provide a usable interview (Tuszynski and Roidt, 1989). The 45% refusal rate after screening was essentially twice as high as refusal in CSFII. The proposed respondent burden (provision of household records plus individual dietary intake data) and the lack of sufficient incentives to participate may have contributed to the low response rate. In addition, structural problems such as use of screening and interview techniques that were not maximally effective and insufficient training and monitoring of the interviewers, high rates of turnover of interviewers, and/or interviewers' failure to follow prescribed schedules may have occurred in the survey.

Inspection of data on demographic information (age, sex, and race) (Appendix D) suggested to the Expert Panel that some differences may have existed between households that provided one day's data, those that provided 2 or 3 days' data, and those that refused to participate further after screening. For example, 86% of white participants who were screened provided one day's data while 78% of black participants provided this amount of data. This suggested to the Expert Panel that race may be a factor in degree of participation in the survey. However, the lack of nonresponse data severely limits any attempt to compare characteristics of responding versus nonresponding households and individuals.

B. NONRESPONSE STUDIES

The LSRO Expert Panel was aware that the contract with National Analysts included a study of the characteristics of nonrespondents. Within the time frame of this LSRO review, the contractor did not submit the data or analysis of data on nonresponse in the 1987-88 NFCS to the HNIS. Examination of the possible influence of nonresponse requires study at the time a survey is being conducted. At this time (1991), conduct of a retrospective nonresponse study would probably introduce many contaminants.

A nonresponse study of characteristics of nonrespondents in the 1986 CSFII (Tuszynski and Roidt, 1989) did not provide sociodemographic information that could be applied to the present survey because only women 19 to 50 years of age and their children 1 to 5 years of age were included in that survey. Little information on nonresponse was available from the 1977-78 NFCS (Appendix E).

C. WEIGHTING SCHEME

The weighting method described by Loughin and Fuller (1990) is a reasonable approach; however, because of the extremely large range and unusual distribution of the weights in this system, the Expert Panel members were concerned with the potential bias that might result from using these weights.

Mean weighting factors for participants in the survey were 23.5 for all individuals, 23.4 for all persons under 20 years of age, 25.1 for men 20 years of age and older, and 22.3 for women 20 years of age and older (Loughin and Fuller, 1990). The range of weights in the existing weighting system is very large (1 to 78 for females more than 20 years of age, 1 to 130 for males more than 20 years of age, and 1 to 136 for males and females less than 20 years of age). This very large range of weights, as well as the unusual distribution of the weights (particularly for females), is troublesome. See Appendix F for a summary of characteristics of women with weighting factors greater than 70.

It is difficult to compare the ranges in the weights from the 1987–88 NFCS to those of other surveys because of structural requirements (equal sample representation by day of week and month of year for the NFCS) and because the one-stage weighting system used in the NFCS did not permit contributions of the nonresponse components to be separated from contributions of the equal day of the week and month of the year requirements. Comparison of the range of weights from this survey with those of other surveys such as the Current Population Survey (CPS) or the National Health Interview Survey (NHIS) is problematic because these other surveys have unequal probabilities of selection and post-stratification adjustments in addition to nonresponse adjustments. Unless the nonresponse component can be separated, it is misleading to compare the ranges of weights.

III. REVIEW AND EVALUATION OF COMPARISONS OF THE 1987-88 NFCS DATA WITH DATA FROM OTHER CONTEMPORANEOUS NATIONAL SURVEYS

Prior to the meeting of the ad hoc Expert Panel, the HNIS prepared a series of comparisons of the 1987-88 NFCS data to similar data from other national surveys to aid in answering questions about the impact of nonresponse on the estimates of food and nutrient intakes. In addition, socio-demographic data from the 1987-88 NFCS were compared with similar data from the March 1987 Current Population Survey (CPS) of the Bureau of the Census (Appendix G) and the Epidemiology Portion of the Cancer Control Supplement of the 1987 National Health Interview Survey (NHIS) of the National Center for Health Statistics (Appendix H). Food consumption and nutrient intake data were compared to three previous USDA food consumption surveys: the 1977-78 NFCS and the 1985 and 1986 CSFII (Appendix I).

A. COMPARISON OF THE 1987-88 NFCS SOCIODEMOGRAPHIC DATA WITH THE MARCH 1987 CURRENT POPULATION SURVEY ESTIMATES

Because the NFCS was designed to be self-weighting, the unweighted data should match the CPS estimates reasonably well if there were no problems associated with nonresponse. Unweighted data on thirteen sociodemographic variables from the 1987-88 NFCS that have been shown to be related to dietary intake were compared to population distributions derived from the March 1987 CPS data (see Appendix G). This analysis showed that there were statistically significant differences for the unweighted NFCS sample relative to the CPS distribution for the following characteristics:

- a larger proportion of individuals from economically poorer households and a smaller proportion from economically richer households;
- a larger proportion of individuals from households with two adults;
- a smaller proportion of women from households with working female heads;
- a smaller proportion of men and women from households with a female head under 41 years of age and no children; and
- smaller proportions of participants 20 to 24 years of age and 15 to 19 years of age.

These findings suggest that there is an underrepresentation of nontraditional families. Those nontraditional families that provided information are vitally important because they are small in number in the sample and, therefore, heavily weighted. If they are not representative of nontraditional families, severe bias could result.

In addition to the concerns about nontraditional families, a question arose in the discussions of the Expert Panel about the designations of urbanization in the two surveys. According to information in Appendices G and J, the categorizations of urbanization were not the same for the NFCS and the CPS. The CPS used June 1983 designations and the NFCS used 1980 Census designations. The CPS estimates of the number of households within a given level of urbanization were regarded as subject to appreciable sampling errors due to the nature of the sampling design. Reweighting the NFCS individual intake sample has not used urbanization because 1) estimates for relative numbers of households based on the NFCS sample and weights supplied by the survey contractor (National Analysts, Philadelphia) were considered much more reliable than similar estimates for the relative numbers of individuals and 2) individual values were believed to have less mathematical dependence on urbanization than household survey values (see Appendix J).

Because of the differences in designation of urbanization between the NFCS and the CPS, analyses comparing the distribution of urbanization of the NFCS sample to another contemporary sample are not possible. Thus, it cannot be determined whether the NFCS sample is representative of the U.S. population with respect to urbanization and whether the weighting scheme has corrected for discrepancies in representation of subgroups. In the NFCS sample, urbanization appears to be a factor affecting intake of food energy and fiber (see Chapter IV).

B. COMPARISONS OF SOCIODEMOGRAPHIC DATA AND FOOD CONSUMPTION DATA FROM 1987-88 NFCS AND THE 1987 NHIS

The 1987-88 NHIS, with 22,080 respondents, had a response rate of about 95 percent. Therefore, nonresponse bias was considered less likely to be a factor in that survey. Some questions on sociodemographic variables were asked in an identical or very similar manner in the 1987-88 NFCS and the 1987 NHIS, possibly permitting comparisons of some sociodemographic characteristics (see Appendix H).

However, a preliminary comparison of selected characteristics in the two surveys suggested that such comparisons probably introduced another series of variables. In reviewing similar questions asked in the NHIS and NFCS, the Expert Panel regarded the questions sufficiently different to limit the usefulness of comparisons of sociodemographic characteristics of participants in the two surveys. For example, the NHIS appeared to have classified single adult households with or without children as one-adult households but the NFCS classified only persons living alone as single person households. Differences in population characteristics with respect to this variable appear to be a reflection of the question asked. In addition, urbanization and Hispanicity were designated differently so that direct comparisons cannot be made for these variables.

Commonalities between food frequency data were also explored as an area of overlap between these two surveys. In the NHIS, participants were administered a subset of the Block food frequency questionnaire containing approximately 60 food items. In the NFCS, participants were asked questions pertaining to frequency of consumption of calcium-rich foods. See Appendix K for examples of questions and comparisons of intakes from the two surveys. Some differences were observed in mean intakes of products in these categories between the two surveys and these were difficult to interpret because of the differences in wording of the questions. For example, the two questionnaires differed in types of cheeses included in the "Cheese" categories and in products added to coffee (milk versus milk or cream). Similar discrepancies existed for most food items in the two surveys.

C. COMPARISON OF NUTRIENT LEVELS AND FOOD USE AMONG HOUSEHOLDS PARTICIPATING TO DIFFERENT EXTENTS IN THE 1987-88 NFCS

To explore the question of whether nonresponse had an effect on the individual intake data of the 1987-88 NFCS, the HNIS compared nutrient levels and food use among households that were classified according to level of participation (Appendix D). In these analyses, households that had provided responses at the household level but did not respond to the individual intake component were compared with households that responded partially or fully in the individual intake component. The mean nutritive value of the household food used was expressed as a percentage of the RDAs for food energy and 15 vitamins and minerals. Use of foods was measured as the mean number of pounds of food used from 51 food groups and subgroups. Both measures were adjusted for the number of meals eaten away from home. Sex and age composition of the household was considered in the comparisons with the RDAs.

Based on the above, the HNIS conducted a MANCOVA analysis which compared nutrient levels of 4,242 households classified according to level of participation. The MANCOVA did not show statistically significant differences in nutrient intakes by level of participation in the survey. The Expert Panel considered the analysis useful for comparing households that substantially completed the household interview and thereby provided some information about similarities and differences among respondents who participated to varying degrees in the survey. However, no information is available about characteristics of households that did not complete the screening step as this MANCOVA analysis could not address total nonresponse. As noted previously, other analyses already suggested to the Expert Panel that differences might exist between responding and non-responding households.

IV. REVIEW OF SUPPLEMENTAL ANALYSES TO ASSESS NONRESPONSE IN THE 1987-88 NFCS REQUESTED BY THE EXPERT PANEL

After considerable discussion of the information provided by the analyses done by the HNIS, the Expert Panel requested three supplemental analyses to assess the impact of nonresponse on the estimates of food and nutrient intakes from the 1987-88 NFCS. These analyses were an attempt to determine whether dietary variables were associated with the variables known to be associated with the nonresponse.

A. ANOVAS

Analyses and information in Appendices D and G established that a number of sociodemographic variables were related to response status. This is of concern in itself and of even more concern if the variables are also related to dietary intake, cost of the diet, and other uses made of the data. Therefore, the Expert Panel considered it important to look at a limited number of dependent dietary intake variables using a simpler approach.

Three hundred sixty one-way analyses of variance were done with unweighted data for intakes of total energy, fiber, poultry, fluid milk, and fruit by the thirteen sociodemographic variables controlled on by the HNIS (see Appendix G) plus several additional variables. The additional variables were: 1) weekday/weekend day, 2) month, 3) living alone (one adult and no children), 4) urbanization (central city, suburban, nonmetropolitan), 5) race (white, black, other), and 6) ethnicity (Hispanic or not). See Appendix L.

1. Sociodemographic variables

Three sociodemographic variables (race, urbanization, and income expressed as percentage of poverty level) stood out consistently as having an effect on intake of food energy and fiber. These independent variables were the ones that, based upon examination of the earlier analyses, the Expert Panel had thought might be important determinants of response status in the survey. This observation indicates that the variables associated with nutrient intake are also associated with nonresponse, increasing the level of concern about the possible effects of nonresponse.

In addition, for subgroups with particularly low response rates, it becomes even more crucial that the respondents in these groups be representative of the entire subgroup, because those responses will have very large weights. Without knowing the representativeness of the respondents in the subgroups, it is not possible to ascertain whether or not the weighting scheme employed has dealt successfully with the nonresponse problem. However, if the responses of individuals who are weighted heavily are unusual, application of a large weight will exaggerate the differences and compound problems in interpretation of the data.

The problem of considering variance versus bias in this situation is very complicated. If there were no nonresponse, concern would exist about large weights falling on individuals who were in some way atypical. This would be a variance consideration. Extreme values weighted by extreme weights lead to very large variances but, if the weighting is done correctly, there is no bias involved in this situation. However, when nonresponse is present and the weights are large to compensate for missing data, it is necessary to rely very heavily on the assumption of missing-at-random for the weighting to be correct and valid for cases with unusual responses. The Expert Panel has no basis

to assume that the nonrespondents are missing at random, nor is the Panel confident that the weighting system employed adjusts completely to bring the sample back in line with the population.

2. Intake variables

Food consumption also varied widely by month of the year and day of the week. For example, fruit intake of men was greatest in November but the sample size for that month was the smallest reported and, thus, will be weighted heavily. Similarly for all individuals, poultry consumption was highest in August, the month with fewest respondents. The occurrence of unusual values in months with very small sample sizes causes concern about nonresponse or noncoverage bias. The small sample sizes for different groups for different months may also point to the presence of a structural problem in the survey; that is, the interviewers did not or could not adhere closely to their schedules.

Examination of differences in food consumption by day of week indicated that the highest energy consumption was reported on Saturdays. Responses were also lowest for this day of the week. Again, this is a situation in which the data will be weighted heavily and there is great concern about the representativeness of the respondents' data.

Household size appeared to be an important variable for differences in food intake; however for persons under 20 years of age, one variable (female head under 41 years of age and no children under 18 years of age present) should be taken out of the adjustment for weighting because of the small sample sizes.

The results of the ANOVAs demonstrated that dietary intake is associated with the same variables that are related to response status. This increased the Expert Panel's concern about the potential for a sizable nonresponse bias in the dietary information. In the next section, the results of employing a weighting procedure are analyzed to determine whether the weights may have successfully removed the effects of the nonresponse.

B. COMPARISONS OVER TIME OF MEAN INTAKES BY FOUR AGE/SEX GROUPS

As shown in Appendix M, mean intakes of five dietary components (food energy, protein, poultry, fluid milk, and fruit) were compared for children 1 to 5 years of age, women 19 to 50 years of age with a child (or children) 1 to 5 years of age, women 19 to 50 years of age without a child 1 to 5 years of age, and men 19 to 50 years of age who participated in the 1977–78 NFCS, the 1985 and 1986 CSFII, and the 1987–88 NFCS. Protein was substituted for fiber in these analyses because fiber intakes were not available for the 1977–78 NFCS. These analyses were conducted with one-day weighted data and the standard errors were calculated taking into account survey designs and weighting factors.

Results from these analyses were similar to the results of analyses shown in Appendix I. Intakes of poultry and fruit were variable and did not show any particular trends over time. The intakes of fruit were so variable and so unusually distributed (e.g., highest intakes in November for men) that the Expert Panel considered those data uninterpretable in regard to the purpose of their evaluation. Mean intakes of fluid milk tended to show less variation over time.

For intakes of food energy, the tables and bar charts showed more similar values for 1987–88 and 1977–78 data than for 1987–88, 1986, and 1985. More similar and greater respondent burdens for the 1987–88 and 1977–78 surveys than for the other surveys may have been partially responsible for this finding.

Overall, the intakes of food energy were consistently lower in the 1987–88 NFCS than in the 1985 and 1986 CSFII. For children 1 to 5 years of age, energy intake was lower by about 125 kcal, for

women 19 to 50 years of age with and without children age 1 to 5 years of age about 100 and 120 kcal, and for men 19 to 50 years of age about 300 kcal. The Expert Panel was concerned about a drop of this magnitude in food energy (which should reflect total food intake) over a short time period.

Between 1986 and 1987, the food composition database was updated to reflect actual changes in fat content of beef resulting from changes in beef trimming practices. An analysis of product changes between 1977–78 and 1985–86 and database changes over the same time period with respect to fat content of foods suggested that product changes made a greater contribution to a decrease in intake of total fat observed in women between 1977–78 and 1985–86 (Perloff, 1988). Changes in coding and probing procedures between the surveys appeared to have little effect on estimated intakes of total fat (Guenther and Perloff, 1990). Mean intakes of total fat of men and children in 1985–86 were similar to the 1977–78 means. Although a decrease in total fat intake could contribute to a reduction in total energy intake, the reason(s) for the decrease in total energy intake for men, women, and children 1 to 5 years of age participating in the 1987–88 NFCS remain to be determined.

Intakes of other nutrients might also be expected to decrease with lower food energy intake and this did appear to be the case for protein intakes of these groups. However, evidence for this was not apparent from the analyses of intakes of other nutrients available at the meeting of the Expert Panel (see Appendix D).

The Expert Panel considered it unlikely that the apparent decrease in food energy intakes actually occurred over a short time period. The finding of lower food energy intakes may be interpreted in several ways. As noted previously, changes in the food composition database could affect estimates of total energy intake. The respondent burden in 1987–88 NFCS was also greater than that in recent CSFII surveys, but was similar to that of 1977–78 NFCS. Another interpretation is that the weighting system is not working or that the weighting system is working and the differences are real. The Expert Panel suggested that the differences may reflect problems of noncoverage (day of the week and month of the year) and nonresponse that the weighting procedure has been unable to correct.

C. UNIVARIATE ANALYSIS OF COVARIANCE FOR FOOD ENERGY INTAKE

A multivariate analysis of covariance provided as part of the initial evaluation of the 1987–88 NFCS data showed no statistically significant overall differences for intakes of 16 nutrients, when considered jointly, with respect to level of participation in the survey. The Expert Panel considered that the multivariate approach was not as powerful as the univariate approach since the effects of all 16 variables may have cancelled each other out even though group sizes were large. Because the Expert Panel was particularly interested in intake of food energy, a univariate analysis of covariance that was focused on energy intake provided an alternative and more powerful means of evaluating whether there were differences in food intake related to level of participation.

The ANCOVA showed that differences may exist by degree of response and it is likely that differences also exist between respondents and nonrespondents. For example, in the ANCOVA run for the Expert Panel, Guenther (1991) reported a p value of 0.016. The Expert Panel concluded that this p value for the analysis suggested that there were differences in food energy intake with respect to level of participation. If differences are seen among persons who participated to different degrees in the survey, it is likely that there are differences between respondents and nonrespondents in the survey. The Expert Panel did not deem it appropriate to attempt to predict any trends about ways in which nonrespondents might differ from respondents from these data and analyses.

V. CONCLUSIONS

A. INFLUENCE OF NONRESPONSE ON THE 1987-88 NFCS DATA

Based on the information available, the Expert Panel concluded that it is not possible, with absolute certainty, to demonstrate either the presence or absence of nonresponse bias in the 1987-88 NFCS data. However, the possibility of nonresponse bias is suggested by the analyses of data discussed in this report. It is not possible to determine the extent to which nonresponse bias might influence interpretation of analyses using these data.

The Expert Panel does not recommend use of the data from the 1987-88 NFCS. However, if the HNIS chooses to publish estimates of mean consumption of foods, food groups, or nutrients, the greatest caution must be employed. The HNIS should include a strongly worded cautionary statement concerning the potential for nonresponse bias in all publications of the 1987-88 NFCS data. Similarly, the HNIS should provide the same information with all public releases of information and data.

It is certainly questionable whether or not the weighted data provide unbiased estimates of the nation's dietary intake. Between group comparisons are still possible but these must be made with the recognition that the respondents may not be completely representative of the subgroups. Such estimates cannot be aggregated to the national level.

If there is a need to utilize the data for estimation of nutrient intakes or cost of meals or of food purchased, further examination of effects of combinations of sociodemographic factors should be completed. Similarly, use of modified or alternative weighting schemes might be explored.

The use of the data for estimates of specific foods or food groups, estimates of upper percentiles of intake, or estimates of intakes of subgroups for which the cell size is small is particularly questionable. Use of these data in time trend analyses in the future will always provide a weak point.

If the 1987-88 NFCS data are used for estimation of nutrient intakes, sensitivity analyses should be done using the 1977-78 NFCS data. If the results are meaningfully different, then the 1985 and 1986 CSFII data should be used to see if there is a trend that would support the difference. If there is not, the 1987-88 NFCS data should not be used.

B. WEIGHTING SCHEMES

The Expert Panel concluded that it is questionable whether any adjustment system can rectify the nonresponse and possible noncoverage (day of the week and month of the year) of the survey. The results of the ANOVAs showing differences in food intakes related to a number of sociodemographic variables magnifies the importance of assumptions concerning representativeness of the respondents. Hence, because of the high level of nonresponse, the Expert Panel is of the opinion that no weighting procedure could give one confidence that it had dealt successfully with the low response rate.

The Expert Panel's concerns about the effects of nonresponse (and noncoverage) were exacerbated by the lack of data on nonresponse. Without a nonresponse study that includes some information on food consumption, there is no way to know whether weighting schemes or any other type of adjustment can account for the problem of differences in respondents and nonrespondents.

VI. RECOMMENDATIONS FOR FURTHER CONSIDERATION

A. ADDITIONAL ANALYSES

The Expert Panel determined that other analyses of the available data would not provide much assistance in reaching conclusions about the effects of nonresponse on the dietary data collected in the 1987–88 NFCS; however, two sets of analyses might be of interest to the HNIS.

- The food intakes of persons with combinations of sociodemographic, day, and month characteristics that result in very high weights should be examined to see if they are unusual.
- Results from the ANOVAs and ANCOVA suggest that simpler analyses may provide information about factors that influenced food consumption of participants in the 1987–88 NFCS. For example, it may be useful to the HNIS to examine intakes of food components by combinations of limited numbers of sociodemographic variables. These types of analyses should be done to investigate effects of combinations of independent variables on food consumption and might suggest particular variables to be used in an adjustment cell process.

B. WEIGHTING SCHEMES

The Expert Panel suggested that alternate approaches for weighting be considered. Since the day and month variables played a major role in the creation of the large weights in the present weighting scheme (Loughin and Fuller, 1990), a two-step approach for weighting that allows for separation of survey effects from nonresponse effects may be useful. Alternatively, a weighting approach utilizing adjustment cells would generate weights adjusted for a smaller number of variables. These approaches are not inherently better than the approach already taken, but the weights generated may have a narrower range and there is less risk of extremely high weights being applied to unusual intake values.

C. IMPROVEMENT OF RESPONSE RATE

1. Monetary incentives to improve response rate

The offer of remuneration has been shown to improve response rate in other surveys (Berry and Kanouse, 1987; Cook et al., 1985; Godwin, 1979; Hubbard and Little, 1988; James and Bolstein, 1990; Mizes et al., 1984). To reduce the percentage of households that refused the screener (14%) and the percentage of screened households that refused the interview (45%), the Expert Panel suggested that a monetary incentive be offered at the time of the initial contact. Results of Berry and Kanouse (1987) suggest a $20.00 check made payable to the person in the household responsible for meal planning/purchasing can be effective. This is a small fraction of the $1000.00 cost per household of surveys such as the NFCS [cost of the 1987–88 NFCS ($7,529,123.)/7,285 participating households]. Persons should be told that they will receive their check in the mail with a letter confirming their appointed interview. They should not be promised the check upon completing the interview because promises have been shown not to work. The goal of the incentive is to establish a bond of trust and goodwill with the respondent (Berry and Kanouse, 1987). Additionally, to increase individual intake response rates, consideration should be given to providing incentives to each individual family member (suggested amount $5.00) at the time of the first household visit. Checks (no cash) should be made out to each household member personally. Because there is no literature on giving incentives during household visits, the latter incentive might be given to a randomly selected test group in the first quarter to see whether or not it significantly improves response rate compared to the control group before being instituted in subsequent quarters.

2. Procedural aspects

It appeared that insufficient training and monitoring of interviewers, possible high rates of turnover of interviewers, and/or interviewers' failure to follow prescribed schedules may have contributed to the low response occurring in the survey. The need for improved management of personnel is an important consideration for improvement of response rate.

3. Respondent burden

The Expert Panel noted that the respondent burden for participants in the NFCS was very great and that it may have influenced the decision to participate at both the household and individual levels. Modification of the survey design and instruments to lighten respondent burden may also improve response in future surveys.

D. NONRESPONSE STUDIES

Studies of nonresponse should, if possible, include collection of information on the major data elements of the survey. To date, nonresponse studies for national food consumption surveys have included only data on sociodemographic characteristics of nonrespondents. For example, the nonresponse study for the 1986 CSFII compared sociodemographic characteristics of nonrespondents with respondents. This procedure did provide some basis for comparison and examination of nonresponse.

It is recognized that collection of data on food consumption from nonrespondents may be problematic; however, in the future, nonresponse studies should, if possible, include questions on both sociodemographic factors and food consumption to provide a more appropriate basis for comparison of nonrespondents with respondents.

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VIII. STUDY PARTICIPANTS

Impact of Nonresponse on Dietary Data from the 1987–88 Nationwide Food Consumption Survey

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List of Appendices
[not included]

A. NFCS 1987-88 Sample Design

B. NFCS 1987-88 Sampling Adjustments for Nonresponse

C. Participation Levels for the NFCS 1987-88 (Basic)

D. Comparison of Nutrient Levels and Food Use Among Households Providing No Individual Intake Data, Those Providing 1-Day Recall Only, and Those Providing 1-Day Recall and Food Records

E. NFCS 1977-78 Nonresponse Information

F. Characteristics of Women with Weight Factors Greater than 70, NFCS 1987-88

G. How Well Does the Unweighted Data from the 1987-88 NFCS Estimate the Proportions of 13 Demographic Variables?

H. Comparison of Selected NFCS Questions with Similar or Identical Questions from the DHHS' National Health Interview Survey

I. Comparison of Data from NFCS 1977-78, CSFII 1985 and 1986, and NFCS 1987-88

J. Level of Urbanization and Reweighting

K. NFCS 1987-88 and NHIS 1987: Comparisons of Mean Calcium-Rich Food Frequencies and Other Selected Variables

L. Mean Intakes of Selected Dietary Components by Sociodemographic and Temporal Characteristics, NFCS 1987-88

M. Mean Intakes of Selected Dietary Components, 1977 to 1987-88

Survey Reports—NFCS 1987-88

Following are reports from the Nationwide Food Consumption Survey 1987-88:

(1) U.S. Department of Agriculture, Human Nutrition Information Service. 1993. Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1987-88. Nationwide Food Consumption Survey 1987-88, NFCS Rep. No. 87-I-1.

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(4) U.S. Department of Agriculture, Human Nutrition Information Service. 1993. Evaluation of Nonresponse in the Nationwide Food Consumption Survey 1987-88. Nationwide Food Consumption Survey 1987-88. NFCS Rep. No. 87-M-2.

For information on ordering these reports, please write to—

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